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ABSTRACT

The advantages research workers will derive from the creation of the proposed computer-based information center are stressed. Most of the techniques needed have already been applied in the physical sciences and engineering. The problem remains to adapt them to the less easily quantifiable variables encountered in the political, social, management and information sciences which are essential to an adequate analysis of the world system. Use of the given techniques should make it possible to move quickly to a stage where there is an interaction between techniques and their adaptation to the available equipment which permits progressively more rapid and sophisticated analysis as well as an increasing "spin-off" to assist practical decision-making. Some features could be quickly available at a low, but useful, level of sophistication. However, the possibility of gradually and flexibly increasing sophistication as techniques improve and funds become available should be recognized. (Author/NH)

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THE IMPROVEMENT OF COMMUNICATION WITHIN THE WORLD-SYSTEM

Research uses, applications and possibilities of a computer-based information centre on national and international organizations and related entities

by

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INTRODUCTION

The need for a general data base as an aid to the investigation of organizations within the world system has reached the stage at which the existing comprehensive and specialized directories and single-purpose surveys are no longer adequate. The equipment currently available and the technological developments promised for the next five to ten years suggest that the possibilities of a sophisticated storage and retrieval system on organizations throughout the world and their interactions should be investigated.

This note identifies some of the uses and possibilities of such a data bank in terms of the probable interests of research workers in the fields of political, social, information and management science and associated disciplines. The applications stressed are those which appear to be important to the control of change within the world system.

An important reason for establishing such a data bank is the tendency to consider the recognized complexity of the world system to be too great to permit any form of unified treatment. Such a view would be encouraged if it proved impossible to represent in a sophisticated model all the entities in the world system and their many types of interaction. Computer display techniques and **processing** ability are the only means of rapidly conveying a conceptual understanding of the many interactions within the system as a whole. Normal instruction methods, in the case of such complexity, cross so many discipline boundaries that they lend themselves to over-emphasis of one particular feature of the system at the expense of others and an integrated picture of the whole.

Research workers in this field are faced with a situation in which the equipment they need is available and will become increasingly accessible and cheap to use, whereas the relevant data and the techniques required have not been brought together. The practical applications arising from the use of sophisticated research techniques in the study of the world system have, therefore, received little attention. A note of urgency is introduced into this situation in three ways:

- the formats and programme specifications of a number of international information systems, particularly those in the United Nations and Specialized Agencies, are under study at the moment. It is probable that a number of specialized information systems will be proposed and planned over the next few years. Research techniques with important practical applications cannot be envisaged in such systems since they have not yet been developed, despite the fact that such systems will collect and store much of the necessary data on sophisticated processing equipment which could permit many valuable analyses. Once such systems are specified and formats are frozen, there is likely to be considerable resistance to any subsequent changes which would permit more sophisticated analyses once the techniques have been developed.

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- the United Nations and the Specialized Agencies are an important group of focal bodies for coordination of the world system. The following comment was made in a report submitted by the United States Member of the United Nations Ecosoc Enlarged Committee for Programme and Coordination ("Development of modern management techniques and use of computers" E/AC.51/GR/L.9, 7 October 1968): "...It has become more and more difficult for any individual, whether in government service or in an international secretariat, to be aware of the totality of the United Nations family programme and activities. This in turn complicates the process of coordination, makes over-lapping and duplication more likely..." For lack of a clear picture of the many interacting sub-systems within the world system as a whole -- which can only be supplied and communicated as a result of multi-disciplinary research -- the solutions currently envisaged by the U.N. are to be specifically based on its own internal organizational problems, despite acknowledgement of the vital role of some other sub-systems.

- the need for sophisticated research techniques is illustrated by the following quote from the introduction to a 1968 management conference session of the College of Management Control Systems (The Institute of Management Sciences). "Evidence is mounting that the environment which managers seek to control -- or, at least, to guide or restrain -- is increasing in turbulence and complexity at a rate that far exceeds the capacity of management researchers to provide new and improved methodologies to affect management's intentions. Faced with the consequences of force-fed technological change, and the concomitant changes in the social, political, psychological, and theological spheres, there is real danger that the process by which new concepts of management control are invented and developed may itself be out of control relative to the demands that are likely to be imposed upon it."

DATA BANK PROPOSED

The data bank would be built up in stages in computer memory, both in coverage (international organizations through to national organizations and important local organizations) and detail (minimum name and address data through to extensive coding of each entity). Initial objectives would be the codification of international organizations (3,000), their national corporate members (30,000) and other important national organizations (20,000 - 70,000). The sub-committees and other bodies with a certain degree of independence within a complex parent organization would also be included. Priority would be given to governmental and non-governmental, non-profit organizations. Other entities important to an understanding of the operation of the world system are meetings, treaties, working programmes (which may be independent of any particular organization), information systems (abstracts, bibliographies), major journals, etc. These would be included in stages depending on user demand and the availability of funds.

The development of the data bank would therefore be flexible. The codification of entities would be arranged so that a greater amount of descriptive coding could be linked to the more significant entities. The difference between types

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of organization or entity would not be stressed, since whatever definitions are used, different types blend into one another. Accepted distinctions would be possible but would not distort the file structure.

An important feature of the data bank would be the possibility of analysing parts of the system represented by the bank information as topological networks (1). Such networks are completely specified by the types of entity and their interconnections. Examples of such networks which are currently analysed with the aid of computers are electrical circuits, programme flowcharts and logic diagrams. The nodes of such a network would in this case be organizations of any kind (commissions, meetings, programmes, information systems, etc). The interconnections or links would be divided into input and output interactions (funds, information, membership, etc.). The file would be structured so that a form of input/output analysis could be undertaken in terms of a variety of variables. This type of analysis would permit, for example, determination of weak points in the network, communication gaps and blockages, overlap and duplication and lack of coordination.

An additional possibility, currently employed as an aid to the analysis of such networks, is the display of a part of the network on a television-type screen. This gives a much clearer visual impression of the network and permits direct interaction via the screen with the computer.

In order to provide a source of finance and to ensure that the data bank is also of immediate practical value, it would be used by organizations for distribution of questionnaires, publication publicity material, meeting invitations, etc. This should help to ensure that the data bank is constantly updated and may provide a link through which development research techniques can be rapidly implemented.

DESIGN CRITERIA

The following factors guided decisions on the design of the file:

1. The file structure should not stress unnecessarily the difference between types of organization (or link between organizations) since, whatever definitions are used, different types blend into one another on some dimensions whilst being distinct on others. Similarities between types may be greater than differences. Accepted and conventional distinctions should be possible but should not distort the file structure. This is the only possible means of making the file useful to a wide variety of researchers and decision-makers interested in the functions performed by overlapping classes of organization. (see Fig. 1, 1a, 1b)

2. A sequential file of data on organizations is completely insufficient in terms of present and expected future demands for information. The file must therefore provide means of showing the links between organizations. This form of cross-referencing within the file is the first step towards representing a variety of 'flows' between organizations. (see Fig. 2)

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3. A network file structure can therefore be conceived as made up of nodes and links. The nodes can be organizational entities of any kind, programmes independent of any particular organization, treaties, meetings, etc. The links, whether input or output, are the channels along which the node receives (or transmits) information, funds, non-financial aid, recommendations, etc. Such links may also represent the membership relationship of 'members' of the node. Links in this general sense can also represent consultative, collaborative, informal and other relationships as necessary.

4. The network file structure should facilitate use of an adaptation of the network and input/output analysis techniques employed in operational research and analysis of electrical networks. Since these techniques have not yet been adapted to this use, the consequences for the file design are simply to separate, to the extent possible, coding relating to node characteristics (static) from those relating to link performance (frequency, volume, type). Provision should be made for the inclusion of coding which would reflect the maximum number of dimensions along which communication and collaboration can break down.

   The objective of this type of approach is to maximize the possibility of constructing models which would be partly quantitative and predictive as suggested by Karl Deutsch (Nerves of Government, p. 126-7):

   > "A part of this development would be the application of cybernetic concepts to the system, making larger and more explicit use of time variables as well as of probabilistic and statistical considerations. This would mean, among other things, the measurement or estimation of the extent and probable distribution of imbalance in the transaction flows, of the corresponding loads upon the equilibrating or adjusting mechanisms in the subsystems; of the lags, gains, and leads in their responses; and hence of the probable stability and future states of the entire system and its parts."

5. Associated with the long-term requirement of systematic network analysis is the simpler requirement that the file structure should facilitate detection of weaknesses (as defined by the user) in coordination or communication between organizations concerned with the same or related problem areas, in order that such bodies could be notified of each others activities.

6. Aside from the problem of distinctions between organizations based on conventional definitions of formal organization types, similar problems arise in attempting to distinguish between permanent bodies and temporary bodies, and between independent and dependent or internal bodies (within an organizational structure).

   A temporary structure such as an independent meeting or a programme may be considered to have an important integrative effect starting from the time it is proposed (and perhaps are called for) to the time the report or recommendations are finally available as a stimulus to further effort. The complete cycle may in some cases be up to 10 years or more. This exceeds the life of many formally constituted 'permanent bodies'. In addition, the borderline between a meeting and an organization, particularly if the meeting forms part of a

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series and has an informal continuing committee, can only be arbitrarily established.

In the case of independent and dependent bodies, it was again decided that, whatever the degree of autonomy, the file structure should permit, if necessary, treatment of the entity in question as a node in the network. This avoids the unsatisfactory procedure of pre-establishing the sub-system boundaries and thus predetermining what is system-external and what is system-internal. The location of sub-system boundaries may itself be an important research objective. In addition, this draws attention to the fact that although communication and coordination between an outside organization and some subsidiary body may be eminently satisfactory, there is no guarantee that the relationship between the central body and the subsidiary body is satisfactory. A sub-sub-system of sub-system A may be affected by a sub-system B without sub-system A as a whole being significantly affected. This has many important consequences.

7. A consequence of the decision not to restrict attention to particular types of organization is that arbitrary definitions of 'international', 'national', 'regional', 'local', or 'governmental', 'non-governmental', 'commercial', etc. are avoided. This permits a researcher to establish his own definitions of such sub-systems with a maximum amount of flexibility.

   This is in line with the conclusions of Andrew M. Scott (The Functioning of the International Political System) that the nation-states are no longer the only significant actors on the international political scene. The file design should facilitate the systems approach suggested by him which would "help overcome the sharp separation between domestic affairs and international politics, because it operates equally well at either level and can move between the two."

8. Most information systems are designed as means of speeding up the processing, storage and retrieval of documents. Because of the high volumes involved such systems are very costly and where they are less costly, this is only achieved by a considerable degree of specialization in order to reduce the volume. To avoid this dilemma and yet optimize information on the world system as a whole, it was decided to concentrate on the producers of information rather than the information produced in document form.

   The information producing and processing points in the world system are organizations of one kind or another. These represent the points at which decisions and control activity regarding the production of information occurs. A focus on such points therefore maximizes the possibility of obtaining a clear, overall picture of the world system. Such a picture is an essential basis for management type decisions concerning the allocation of resources.

   A management information system requires information on bodies controlling, evaluating, formulating, and implementing programmes, and coordinating memberships (in the broadest sense), relationships and information networks linking them to problem areas.

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It is therefore focussed on the coordination achieved and necessary for current and planned or proposed activities. A documentation information system concentrates on the information produced when it eventually appears in published form.

The first is focussed on the initiating points for present and future activity whilst the second is focussed on the published record, if any, of past activity. The fact that one organization can coordinate the production of many documents in the context of one programme, is an indication of the volume of information in each case, the scale of the problem in each case,, and the cost of each type of system. Most important though, is that it illustrates the relatively much higher value of information on the current programmes of organizations.

Intermediate between these extremes, is information on sources of information produced in document form (e.g. bibliographies of bibliographies, directories of periodicals, etc.) which can be incorporated in a management information system, since it represents the key to information collecting points and systems in a particular problem area. Such information is of relatively much higher value if it is produced regularly within a series rather than as a one-off publication.

The file structure is therefore deliberately not orientated toward the solution of the documentation problem and the associated 'information explosion'. Such solutions imply the retrievability within a 'reasonable' period of time of an optimum number of past relevant documents on a subject. A management information system implies the immediate availability of information on all currently active bodies, programmes and information networks within the world system. It can, to some extent, predict future document production.

The emphasis on the management approach is based on the view that even if a document information system can provide an optimum selection of relevant material on a problem, this does not facilitate the solution to many important subsequent problems. Specifically:

- decision-makers are increasingly in a position in which they can no longer afford the time to wait for libraries and information centres to complete the documentation retrieval cycle. Having received a pile of documents, they are no longer in a position to read and assimilate all the information supplied.

  Not only does the time factor come into play, but also the problem for the decision-maker of determining the relevance of analytical results based on the techniques and assumptions of disciplines with which he is not familiar. If they are 'foreign' to him, his inclination to use them will be low, even if he studies the results in detail. This is a major problem in the utilization of research implications for policy formulation.

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- a request for documents is specific. The documents received are the answer to the request. They do not automatically supply an operational context for the problem area in question, particularly where it may cross specialist or jurisdictional boundaries. The documentation information system is 'blind' to this approach, particularly when set up within a specialist organization with an accession profile designed to minimize acquisition of material from other fields. The more general the request, the more material supplied which must be interpreted, restructured and assimilated.

- the response of a documentation information system is a response from the past and cannot take into account current developments (even the lag between production and publication of a journal article may be several years).

- a documentation system is not dynamic. It cannot permit analyses which could signal probable problem areas. The decision-maker is therefore dependent on historical reports to detect a problem, unless it has reached crisis level and been reported through not documentary channels across the accepted jurisdictional boundaries.

A major requirement for a management information is that it be highly structured, eliminate non-significant data in order to highlight problem areas and areas requiring decisions. It should also relate a problem area to associated problem areas across discipline and jurisdictional boundaries. It should indicate the location of resources and the channels through which they could advantageously be moved. An attempt should therefore be made in designing the file structure to facilitate the development of techniques of this kind.

9. Another approach to the analysis of the world system is through the use of political and social indicators based on statistical analysis of the relationship between key variables in a manner analogous to that used for economic indicators. Major difficulties associated with this approach are cost, comparability of data collected in different countries and ensuring regular updating.

This approach provides indications of conditions of clearly defined classes either by national, regional or local averages. It does not tie these conditions directly to the organizational structures within society by which they can be modified and tends to gloss over the structure of sub-systems and communication within and between them. Thus although primary problems can be detected, the detection of secondary problems is not facilitated e.g. the structural weaknesses which obstruct the effective recognition of, or implementation of solutions to primary problems (nor does it facilitate the detection of structural strengths by which solutions can be speeded up).

The greater the emphasis placed on structural elements within the world system and dynamic relationships between them, the greater should be the practical value of the file when set up. The incorporation of general political and social indicators was therefore envisaged but only as a part of the node or link description coding.

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10. The file design should not be an attempt at model building but should rather provide the elements from which a wide variety of partial or general models could be built. It should be left to the researcher to define the classes into which he wishes to group entities for model building purposes.

The advantage of this approach is that an attempt is made to include as many different types of entity as can be detected. The researcher is therefore forced to explicitly exclude certain types of entity when building partial models, rather than merely neglect certain types of entity because their significance has not been brought to his attention.

11. Additional factors governing the design arise because of the practical problems of implementing and maintaining the system. These are:

- flexibility of development. It would be impractical to introduce a large amount of data before making use of the system. The file should therefore make provision for build-up

  a) in number of entities included over time
  b) in detail included about entities
  c) of new types of detail not envisaged at the time when the file structure was designed

  This permits the file to be extended in response to demand and as funds become available without any need to follow a predetermined order of development. The stored information should be of optimum utility at each stage in order that it should immediately justify funds allocated to the project.

- initial focus on the international system. Since the network of international organizations and related entities supplies a basic structure for the world system, the file should be developed down from international organizations, through their national members and then include other national entities and local bodies of great significance. In this way the file would be focussed on the most 'coordinative' entities of the world system, at each stage.

- low priority for commercial bodies. Since commercial organizations are very well documented and have already been incorporated into many sophisticated information systems, it should not be necessary to include them initially. Exceptions to this would be mutlinational enterprises and their national subsidiaries, together with research institutes set up for commercial purposes. The file organization should not however preclude incorporation of profit-making bodies as such, in those cases where they are considered to be of interest.

- mailing list preparation. To provide a source of funds, as well as to facilitate file maintenance, it was considered necessary to design the file in such a way that names and addresses of organizations could be conveniently listed in a flexible manner for mailing, survey questionnaires and directory preparation purposes. Unless the system is used a great deal in this way, insufficient mail returns are received to feed back corrections and keep the system up to date, and therefore of continuing value.

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It is only by being in a position to supply mailing list information that the system can make practical use of research techniques developed to detect unnecessary communication and coordination gaps and their effects on programme implementation. Following on from this, the greater the extent to which the mailing list use of the system can be facilitated, the greater should be the value of it to those organizations included which are faced with communication and coordination problems.

- receptiveness to data in a wide variety of formats. In order to maximize the value of the system to different research groups and to increase the detail included on entities, the file should be able to incorporate survey data on entities and links from many sources without any need to completely restructure and recode the data.

- new computer input/output techniques. Since the system would be developed over a period during which remote and/or visual display terminals will become increasingly accessible and low in cost, it is necessary to minimize the difficulties in making use of these devices for retrieval and display of information. Use of visual display devices in particular, should considerably facilitate attempts to represent the operation of the world system, both in general and at a detailed level, from the static (structural) point of view and from the dynamic aspect (inter-entity flows, proposed structural modifications).

12. Finally, the file organization had to be kept reasonably simple to facilitate input and updating.

The most important factor implicit in many of the points above is the generality of the required file design. Because of its generality, the system should be of value to a wide variety of cross-category queries and permits the construction of models of the world system as a whole. The difficulty inherent in optimizing a general design (aside from that of locating financial support) is illustrated by a quote from Bertram M. Gross (The State of the Nation, p. 138) on the preparation of general social indicators:

> "Most proponents of new indicators, however, are mainly interested in some special category of data -- say, educators in educational indicators, psychiatrists in mental health data, sociologists in information on stratification and mobility, political scientists in voting behavior and political attitudes. Activitists in all fields are interested in new information that will help to vindicate their position or indict the opposition.... Only a small minority of proponents -- whether on the producing or the using side -- are interested in enough new indicators to provide comprehensive social systems accounting."

ENTITIES INCLUDED

The file will permit the inclusion of the following types of organizational entity. It is however highly probable that the different groups will be given different levels of priority, approximately that of the order here. Individual entities from low priority groups could of course be included at any time if necessary. The groups

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are based on conventional categories, but the file organization will of course permit much more flexibility in selecting categories.

- international governmental organizations
  organizations of international non-governmental non-profit organizations
  international non-governmental non-profit organizations
  regional international organizations
  international meeting series
  multinational business enterprises

- commissions and sub-commissions of international organizations
  particularly where they may have independent fields of activity, names which may create the impression that they are unconnected with the parent body; also cases where the links between the secondary body and its parent may be of significance to an understanding of the operation of the parent body or the mechanism by which a particular problem is dealt with

- organizations of national non-governmental, non-profit organizations
  as the major coordinative bodies for non-profit activity

- libraries and information centres

- national organizations (governmental and non-governmental) with international programmes or interests
  significant state or local organizations with international programmes or interests
  particularly where such organizations are important to the implementation of international programmes and where they are the only ones of their type in the country (or the world) and may therefore be considered of international significance. Such organizations may also represent the major source of potential membership of international non-governmental organizations, or in the case of governmental bodies, for the implementation of international recommendations

- bilateral international organizations

- international programmes, projects, "days", etc.
  particularly where these are independent of any individual organization or have names which create the impression that they are organizations or independent; also cases where collaboration of organizations through the programme is of importance to an understanding of the mechanism by which a particular problem is dealt with

- international treaties and agreements
  particularly where these take over the normative functions of organizations or are the principal reason for the existence of an organization

- international journals, directories, abstracting or bibliographical services
  particularly where these in effect take over the information processing and disseminating function of international organizations or are the principal reason for the existence of a particular organization or are in effect the most important 'coordinative structure in that field

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- individuals holding positions in international organizations
  international roles or positions
    particularly where the positions held by one individual are such that he himself performs an important integrating function in linking organizations (e.g. cross-linking directorships in business enterprises, or individuals holding positions in government and in non-governmental organizations)

Clearly there are many similar types of entity at the national level which could be included if this was considered justified. The emphasis above has been placed on the geographical coordinating function of entities. Equal emphasis could be placed on cross-disciplinary or cross-jurisdictional coordinating functions, and priorities could be allocated accordingly.

The concept of entity is sufficiently general to permit inclusion of other types of entity if necessary. Possibilities are considered in the next section.

COMMENTS ON OTHER POSSIBLE ENTITIES

The purpose of considering other possible entities is to arrive at greater facility in identifying and describing parts of the world system.

Sub-Systems and Classes of Entities

Sub-systems may conventionally be identified by name (e.g. international NGOs, the American banking system, etc.). Descriptive coding can be supplied, as can keyword coding. The actual entities which make up (i.e. are 'members') of the sub-system can be clearly defined, individually or as classes and thus cut down access time. Such cards would be a useful means of avoiding analysis. A library of sub-system cards could be built up as a result of each analysis of the file as a whole. Each sub-system would be defined according to the special definitions used by the investigator. The result might be that of a series of overlapping classes which had together employed definitions which effectively excluded some specific entities registered within the file. This in itself would be useful.

In some cases the sub-systems would in fact represent a non-existant umbrella organization.

Depending upon how the systems were defined, it could be useful to include "black box" system cards known to be important parts of the system with known inputs and outputs, but about which it was impossible to provide any description with certainty.

Religions, Armies, Tribes and Clans

The manner in which the system is conceived does not preclude treatment of these as entities. Their heirarchical structure and cross-links to other entities could easily be indicated.

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Movements of Opinion and Informal Organizations

Since a structure can be identified for informal organizations and, using classes of entities, movements of opinion, there is no reason why these important features of the world system should not be included, if this was considered necessary.

Information and Communication Systems or Networks

Information networks may be independent of any particular organization and may therefore be considered to be important integrating factors in their own right. They possess a well-defined structure and may therefore be included if necessary.

Decisions

Where a decision is taken as the result of the deliberations and activities of a wide range of organizations not necessarily formally linked, it would be an advantage to treat the decision as a type of entity in its own right. The organizations which participate in the decision-making process may then be treated as 'members' of this entity.

As a detail of an organizational structure, cards of this type could be used to indicate the inputs and outputs to decision centres.

Propositions

At some stage, it would be an advantage to store propositions concerning the functioning of the world system and its sub-systems. They could be filed at any stage of verification, so that apparently contradictory propositions could exist together. Each would have its status changed as it moved towards acceptance or rejection.

The value of including propositions once the file is used for simulation and decision-making is to offer the user a choice of relationships governing a field in which he is interested, plus all the necessary qualifications. A proposition verified for a limited set of cases could be drawn to the users attention as a possible guide for a decision in his unexplored area.

It would be useful to express propositions concerning flows or restriction on flows between entities or classes of entities as simple mathematical functions. In fact it is probably only propositions which can be so expressed which could be usefully included.

Criticisms

Inclusion of data from a variety of sources will clearly lead to a situation where two or more sources of different standpoint will disagree. This disagreement is itself a feature of the system and important to an understanding of its operation.

Provided a critic card follows the same format as the card of data criticized, either may be chosen, or the two compared to establish the degree of dissonance. An example would be a comparison between stated objectives and some evaluation of the 'real' objectives, or of what is really being achieved.

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Problem Areas

Consideration has been given to means of coding problem areas, as distinct from subject or field of interest areas. An organization can be concerned with a field of interest selected from some sort of representation of the totality of possible fields of interest and ordered into classes and sub-classes. It would be useful to develop a structure of problems with which entities can be concerned. In effect this is an ordered collection of ways in which any entity and in particular, (by extension) the world system, can malfunction.

This problem thesaurus could be used as a qualifier on field of interest coding to indicate in what way the field is of interest or is a matter of concern, thus clarifying the objectives and activities of the organization. Alternatively, problem areas could be treated as entities with a 'membership' corresponding to those bodies concerned with them.

In the first case a valuable predictive tool would be created. For if analysis shows that a number of organizations are concerned with a limited number of problems within a particular problem area, it will bring out those aspects with which no organization is concerned and concerning which data should be obtained, even if only as a check. In this way a systematic picture could be built up of what might go wrong in the future, or might be wrong, but be undetectable because no body employs the conceptual categories necessary to detect the problem, possibly because it is interdisciplinary.

Presumably such a problem hierarchy would at its more abstract end include the vague concepts included in organization objectives, about which it is possible to enthuse e.g. cooperation, well-being, etc. At its more detailed level, it would include statistics of the problem as measured. It is the intermediate levels which would prove of value as a guide to decision-making.

The disadvantage of this approach is that no generally accepted and highly developed problem thesaurus exists. Insufficient is known about system malfunction in the most general sense. Even 'problem' does not seem to be very well defined in the system sense. (see Fig. 2b)

The second approach is simpler but more ~~closely~~ related to the field of interest coding. The problem area could be treated as an entity with a membership. Related problem areas could be linked using the inter-entity link cards. Because this is an associative type of coding, no predictive feature is available, but it does increase the ability to evaluate the degree of coordinated response to a problem. area.

If fields of interest were coded as entities, then problem area coding would blend into field of interest coding. A field of interest could then be considered as a problem area in a broader sense.

The link between an organization (say) and a problem area is then that the organization is set up because the problem there is considered critical. Organizations could then be considered as society's response to a problem area. An organization may express concern (general interest) about certain symptoms, but consider that an indirect approach was necessary. The problem area attached may therefore not be identical with the symptoms of concern.

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An advantage is that an attempt is made to distinguish between ways in which an organization is concerned about a subject area and how that subject area is defined as a problem and how it is proposed to attack that problem. This sort of qualification on field of interest coding would avoid superficial analysis identifying duplication when the two bodies were concerned about the same area in different ways. It would also highlight those cases where an organization is apparently the authority in a certain field of interest but in fact is only responsible for certain aspects of that field of interest.

This sort of problem area approach would help to take the emphasis off documentation about a field of interest and place it on the way in which that field of interest constitutes a problem and what needs to be done about it.

RESEARCH USES (see Fig. 3)

Interaction between workers and the data bank over a period of time should ensure that increasingly precise techniques of coding and processing the entities and their interactions are developed and incorporated wherever possible. The fact that the entities described are real and not artificially generated should lead to research techniques and models or conclusions which would prove of immediate practical value.

Research workers could use the data for:

- sequential statistical analyses of organizations
- simulation data base by copying sections of the file
- experiments on the representation of parts of the world system structure by modifying entities and their interactions -- particularly in an interactive graphic mode using a 'light pencil' and television-type display
- development of new techniques for analysing the system of organizations represented by the data base
- development of practical applications in the field of decision-making, particularly as a possible aid in meetings for planning purposes
- development of practical applications in the field of education.

Use of the data bank for contact purposes, particularly if it is constantly updated with future meeting and proposed programme data, would in itself be of great value to research workers attempting to establish and maintain contacts with all bodies operating in their particular field of interest. One application envisaged is the use of the data bank to assist in the distribution of meeting results.

It is not possible to present the various research uses of the proposed data bank in clear categories by discipline. The many factors to be taken into account in the analysis of the world system interact across individual discipline boundaries. In addition, the research interest may be in the development of an analytical technique, in the practical application of a technique, in the creation, manipulation and analysis of models, in the summarization of data to give an adequate picture, or in the adaptation of theoretical techniques to the restrictions and communicative powers of a display unit.

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The following problem areas may combine any of the above needs for research, depending on the state of development of the theoretical techniques, their adaptation to the equipment available and the restriction imposed by the context in which the new techniques could be of practical value.

Correlations between Organization Characteristics and Interaction Variables

This has been the main area of quantitative research. The data bank should considerably facilitate the conduct of preliminary and general inquiries by providing most of the useful basic quantitative information on organizations. This should prove of great assistance in narrowing down the area of research and clarifying the problem and the number of questions that need to be asked of organizations. It is important to recognize the disadvantages of over-questioning under-staffed organizations. The data bank would also facilitate the mechanical process of preparing the necessary questionnaire envelope labels. Under present circumstances the address location problem which this facility would overcome, is in itself a very important hinderance to research. The key question here is the minimum and optimum number of characteristics that must be coded on each type of organization (important and less important) now and in the foreseeable future, bearing in mind the possibility of flexible extension of the coding on each organization. Feedback on this point would be of great assistance and is probably essential to the adequate design of the system.

Factor Analyses

It is intended to avoid, as far as possible, freezing any descriptions of organizations according to currently favoured definitions. Provision would be made to permit analysis in terms of such definitions if necessary. Coding should, however, permit analysis todetermine to what extent a particular combination of characteristics chosen at the time of research is a valid or adequate definition of a class of organization or interactions in any subject or geographical area. This is particularly important in order to facilitate adequate analysis of types of organizations which fall in the gray areas between the boundaries of accepted definitions. Clearly this lends itself to the use of the factor analysis technique.

Input/Output Analyses

Experiments with adequate definitions of organizations should lead to the development of a form of input/output analysis of organizational systems. This could be based on the flow of information but techniques could be developed, with the aid of the data bank, to extend this to measurable characteristics representing less easily quantifiable flows such as policy implementation, finance, membership support, etc. Such techniques could be used in conjunction with factorial analysis which should reduce the delays in arriving at adequate models. In order to achieve this satisfactorily in the face of the practical problem of limited, inadequate or excessive amounts of information on organizations, statistical techniques would need to be developed to supply probable values in the case of limited information and to summarize excessive amounts of information where this cannot be stored permanently.

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The investigation and development of such techniques, assisted by the data bank, could hopefully lead to a useful method of specifying typical response curves for different types of organizations considered as nodes in a topological network. Such a technique would provide guidance in the management problem of optimizing organizational structure and interaction and of portraying the system in a more meaningful and dynamic manner.

Information Flows

An important coding possibility would permit the analysis of the world system in terms of the flow of information along channels represented by information systems and other forms of contact between organizations. The results of such analyses should bring out the position, characteristics and weaknesses of information channels, storage, retrieval and processing points. An understanding of the world information system and ways of improving it could prove very useful in isolating factors contributing to the creation or maintenance of conflict.

An adequate analysis of information flows would provide an essential basis for recommendations for the creation of new bibliographical, documentary, library and journal information services. Such an analysis would permit the development of a technique of contour mapping of the probable number of information search operations (or the probable delay) necessary for a person in a certain subject and/or geographical area, to contact another person (or tap an information flow) in another area.

Systems Analysis (see Fig. 2)

The above techniques should provide an adequate basis for a useful dynamic analysis of the world system. The interactions are so complex that it is highly probable that a complete picture could not be portrayed in any meaningful static form. Techniques would have to be developed to select out, summarize statistically, and display parts of the system in order to provide adequate conceptual models to facilitate understanding. The advantage of the data bank would be that it provides a base from which many such techniques and models may be derived and examined. The advantage of the proposed system, however, is that it provides a common base by which partial models are in effect linked, in contrast to current procedure where, for example, a political model would not necessarily be based on the same entities as a sociological model, and the two models would not interact. The system is therefore a form of guarantee that all aspects of the world system are potentially accessible, even if a researcher of necessity chooses to work with one aspect at a time. This integrated multi-aspect possibility is an essential requirement for any management problem analysis.

Simulation

The data base would prove extremely valuable to the simulation of the operation of sub-systems of the world system. Such a simulution could focus on political, sociological, information and financial or other aspects. In the case of political science, for example, little empirical work has been done on which theories could be based. The lack of an adequate comprehensive data base has also inhibited attempts to derive theories inductively. It is through simulation

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that possible relationships among any or all variables put into the simulation may be examined. Simulation can therefore be used as a theory building and a theory comparing device and can aid in accelerating the development of fundamental knowledge in international politics (2). Clearly these points can also be made in favour of simulation of other aspects of the world system. The fact that such simulations are based on uptodate data about the real world -- data in a system which is also used for non-research purposes -- and not artificially generated, considerably increases the speed with which research conclusions can be made use of as guides to practical decision-making in both governmental and non-governmental spheres. A particular advantage when interactive display units are used, is the possibility of rapidly introducing response or probability curves as a hand-drawn "light curve" to change the characteristics of a simulation. This avoids the need for lengthy numerical specification of curves.

Interactive Graphic Displays

A research worker involved in theory building, technique improvement, analysis of the world system or sub-systems, development of methods of practical application, or investigating parts of the world system as a guide for decision-making purposes, could be equipped with an interactive graphic device linked to the proposed data bank.

These devices usually involve a cathode ray tube, a light-pen or equivalent device for drawing and manipulating graphical data displayed, an associated keyboard, and possibly an array of push buttons and toggle switches for designation of certain user-defined computer subroutines and macro instructions. Such routines can be used to increase or decrease the amount of detail in the display modify the dimensions or coordinate system of the graph, etc. Data can be fed onto the display (and thus into the computer) using the light-pen, the alphanumeric and function keyboards.

In order to treat very large structural entities graphically (e.g. a complex organizational network), the display surface can be set up to represent a window on, or projection of one aspect of, one part of the structure. For a particular application it may be necessary to work with a number of such detailed sections by 'moving' the display window to view different portions of the entity as a whole. A capability can also be provided to 'zoom' in on a small portion of the structure, if it is three-dimensional, in order to get a better picture of the relationship or lack of relationship between the parts. Dynamic capabilities can be added to the above. Analysis of various types of weakness can be provided and signalled to attract the attention of the research worker or decision maker. At any time, he can request further information in textual or graphical form on parts of the structure.

In order to understand the value of interactive computer graphics, a few basic principles of communications should be considered. Languages convey thoughts. The most primitive language conveys a small portion of the total thought in a language unit. The spectrum from binary computer language through textual description to graphics may be considered as a hierarchy of languages. A picture, curve or chart is a unit of graphic language. The cliché "one picture is worth

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a thousand words" describes the power of a unit of graphic language to express thoughts. Raw analytical data must be plotted or structured to draw attention to significant details and bring out its full meaning. Until this is done, it is difficult for the individual human information processing system to construct efficient data structure models of the content of a mass of data. It is only by using such structures that complex data becomes easy to manipulate and remember. A measure of the degree to which some form of communication approaches the ideal is the degree to which it is understandable weeks or months after it is written, not statement by statement, but in the structure of meaning that it reveals or conceals. Graphical communication is inherently structural and therefore ideal where complex structures and interactions must be analysed by research workers and subsequently displayed for the benefit of decision-making.

Real-time computer graphics makes it possible for the research worker to describe his problem in terms of charts, graphs, schematics, pictorial views, etc. and have his analytical results portrayed in a similar form. All of this is accomplished within a time which makes it possible to maintain "thinking momentum", which permits questions to be quickly rephrased in the light of each analytical response. For the decision-maker, particularly in committee, the system allows him to access quickly detailed evidence only for those points of the displayed summary which are questioned. (3, 4, 5, 6, 7, 8)

The fundamental importance of interactive graphics is the ability to facilitate understanding. Progress in understanding is made through the development of mental models or notations that permit a simple representation of a mass of complexities not previously understood. The greater the complexity however, the more difficult it is to use mental models. For example, in a discussion of mental models of electrical circuits one author writes: "Unfortunately, my abstract model tends to face out when I get a circuit that is a little bit too complex. I can't remember what is happening in one place long enough to see what is going to happen somewhere else. My model evaporates. If I could somehow represent that abstract model in the computer to see a circuit in animation, my abstraction wouldn't evaporate. I could take the vague notion that "fades out at the edges" and solidify it. I could analyze bigger circuits. In all fields there are such abstractions. We havn't yet made any use of the computer's capability to "firm up" these abstractions. The scientist of today is limited by his pencil and paper and mind. He can draw abstractions, or he can think about them. If he draws them, they will be static, and if he just visualizes them, they won't have very good mathematical properties and will fade out. With a computer, we could give him a great deal more. We could give him drawings that move, drawings in three or four dimensions which he can rotate, and drawings with great mathematical accuracy. We could let him represent all kinds of very complex and very abstract notions, and we could let him work with them in a way that he has never been able to do before. I think that really big gains in the substantive scientific areas are going to come when somebody invents new abstractions which can only be represented in computer graphical form" (4) (emphasis added). It is this sort of facility which the political, social, information and management scientists and educationists require in their studies of the world system and its sub-systems. It appears highly probable that only abstractions of the above order will prove an adequate basis for an understanding

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and representation of the world system for purposes of sophisticated decision-making.

Decision-making Research

The need for comprehensive research on means of facilitating the decision-making process within the world system is illustrated by the following quote: "We know much of what the future will bring in terms of problems. We know they will be big, complex, and serious....These problems represent the givens. We know they will be there -- and we know they will overwhelm us if we do not find the means of coping with them. What we lack, thus far, is conviction that there is a means of getting hold of them. They seem so staggering in their size and complexity -- so far beyond the capability of any single institutional segment of the community, public or private....And they are so interrelated that to proceed to try to solve any one of them in isolation from the others is often to create more problems than are solved by the effort. The dilemma thus presented has so far frustrated most efforts to come to grips with these problems. This condition of paralysis need not obtain. None of the...challenges lies beyond our already existing capacity for coping with them. The tools are already at hand; and included in those tools are not only the technological capabilities but experience in systems management and systems analysis as well as proven patterns of joint public and private effort." (emphasis added) (14).

The techniques used to handle development programmes are, even in the systems oriented U.S.A., "still operating on the old project by project basis. Problems are subdivided into manageable units, but rarely are those units coordinated into a comprehensive pattern. It is rarer still for one program to be related to another, particularly in a case where agency jurisdictional lines do not overlap....There is no lack of criticism of this haphazard approach to major national problems. Nevertheless, when the gains made in coping with our environmental problems are stacked up against the exciting breakthroughs that have been made in our aerospace efforts, it is clear that we are improving the quality of human existance here on earth at too slow a rate....In my judgment, we are on the threshold of an entirely new approach to the solution of these public problems....What I am talking about, of course, is systems management....Computers...are merely tools of the systems manager; they increase his capacity to make good decisions by improving the quality and quantity of his information. The amount and quality of available information are critical to the success of public programs. Far too often, however, decisions are made with inadequate data, usually because not all of the necessary factors were taken into consideration. As one local government official described the public management process, "We manage by reaction rather than design". Use of the array of tools available to the systems manager can immeasurably improve the quality of public decision-making, and hence the quality of public programs." (emphasis added((15). It is this approach which is required to solve the decision-making problems within the world system. A first step, however, must be a comprehensive and dynamic collection of information on all the organizational entities involved in the initiation and control of change. Research will then be required to adapt or develop the appropriate techniques for portraying and predicting the interactions between these entities.

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As the world system organizational structure and range of inter-organization interaction increases in complexity, new means must be sought to facilitate (a) the task of the planner and decision-maker whether in inter-governmental, governmental, international or national non-governmental organizations, or in meetings of any type; (b) the interaction between decision-making research and decision-makers. It is not possible to expect decision-makers under time pressure to be able to locate and absorb all the serially presented textual and tabular material relevant to each problem and the techniques required to solve it. New techniques must be sought to summarize, structure and automatically highlight problem areas and their relation to the various types of resources available for a solution, in a manner which is oriented to the requirements of the decision-maker or the type of meeting in which decisions are made. This is particularly important where a range of new and perhaps complex techniques of analysis has been developed but can only be used by the decision-maker under clearly defined conditions, with appropriate qualifications, to be of value. The interactive graphic display is an important new aid to the controlled analysis of these decision-making problems. "It is superfluous to point out, for example, that an incidence matrix, while completely describing a graph, is a poor substitute when it comes to being an aid to human intuition and understanding. A similar reflection applies to tables of values that describe functional relationships; a graph is immediately clear, while numbers are not."(7)

An important additional value of graphical displays and particularly interactive graphical displays is the guidance it gives to any meeting discussion. The minimum amount of information on a complex structure is successively displayed for general comprehension and to focus on the major problem areas as they are to be discussed. Specific detailed queries by participants can, however, be met and answered within the general context without endangering the meeting momentum as a result of the confusion easily created by reference to topics or perspectives whose detailed relationship to the topics under discussion has not yet been adequately prepared. Under normal circumstances, the meeting momentum and sense of direction may be modified by such statements in the absence of adequate information, drawing the attention of the meeting away from the critical areas and perhaps apparently justifying the postponement of a decision.

Interactive graphics may therefore be used as a means of structuring and interrelating problem areas and highlighting those on which surveys must be carried out. It is an ideal tool for vividly and automatically highlighting (and if necessary supplying a textual description) communication gaps or inadequacies, lack of coordination and duplication within a complex organizational structure. It has the advantage of being able to draw attention, on exactly the same basis, to such weaknesses between interacting divisions of organizations within the world system which have no direct formal structural links.

A central data bank, or one operating through regional centres, can maintain an integrated picture of the world system updated from a wide variety of sources. Any modifications, dissolution of old entities, creation or proposal of new entities and interactions can be ordered in relation to the other entities affected. This has the valuable consequence that duplication of corrective action is not made by one decision-maker during the time delay (sometimes

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measured in years) before he registers (if he does) the actions of another decision-maker concerned with the same problem. Each decision-maker has a dynamic information picture of the environment with which he is concerned. This picture is not distorted by the administrative restrictions imposed on his interactions with, and recognition of other entities.

In engineering terms: "The primary problem encountered when designing a large complex system is to control the utilization of three-dimensional space during the layout process. In a large system the work of numerous specialists must be closely coordinated in order to ensure that no two objects are placed in the same space, and that the interaction of layout and system characteristics does not unnecessarily degrade the performance of systems. Ideally, everyone would work on one large drawing....However, one large drawing -- actually -- is obviously impractical. Using interactive computer graphics, however, it is possible for everyone to work on a "single drawing"; through linkage of the graphics with analytical programs, the correlation between layout of a system and the system performance characteristics is automatic." (5)

International Treaty Research

A major problem in dealing with the multitude of bilateral and multilateral treaties is to discover which subjects are covered by which treaties and which are not covered by any treaties. This problem extends to the national level and is aggravated by the fact that international treaties are usually only in effect for a limited period. The proposed data bank, by processing a treaty as an organizational entity (without an administering secretariat) could, in conjunction with a visual display unit, quickly give a dynamic visual impression of what fields were not covered now (or would not be in the near future), in what fields several treaties had to be considered. By relating treaties to organizations and programmes concerned with the same subject, their normative value is considerably increased.

ECONOMICS OF INTERACTIVE COMPUTER GRAPHICS AND THE FUTURE

The problem of management guidance necessary to control change within the world system, highlighted by the quote at the beginning of this note, will require increasing interaction between the functions of: research, decision-making, problem evaluation, programme implementation, and public information. At present, these functions are, in many problem areas, the responsibility of organizations or departments which only interact indirectly via a long series of unorganized and only partially understood (from a systems viewpoint) processes and delay mechanisms.

The proposed data bank could provide an information base as a nucleus for the development of a structure which would increase the speed of interaction between the above functions within the world system. National and international data transmission networks and information systems are now being planned and in some cases implemented. Where the above functions can each benefit from use of the same data base, problems registered in one functional area can quickly lead to response from the other area, e.g. a decision-making or problem

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evalutation problem will stimulate research and lead to the rapid use of research conclusions and techniques. It is already possible to envisage the state at which the decision-maker may be able to benefit from research techniques weeks, instead of years, after they are developed, because of interaction **via the** functional area, through the type of information bank proposed. Similarly, a particular decision-making problem may become more clearly defined as a stimulus to the researcher.

The ultimate measure of value of any innovation must be the financial and indirect returns on the investment. The future cost per console hour for time-shared computer graphics was anticipated in 1968 to be $ 12-15 in the "near future" and $ 1-2 in five to ten years. Such systems may be operated over telephone or data transmission lines so that the interactive computer graphics terminal must eventually become a piece of office equipment (rather than part of a computer installation). Complete graphics systems could, in 1968, be purchased at costs between $ 15,000 and $ 50,000. Tangible benefits derived from the use of graphic systems include: reduction in the number of man-hours required to test a single solution to a problem; reduced use of computer time due to the users ability to "zero-in" on the correct answer; direct savings of man-hours required to translate problem descriptions into computer input; savings as a result of computer reduction of raw data output to graphical form. (5, 9)

The intangible benefits are primarily in the area of problem solving. Graphics has spurred some users on to attempt the solution of future problems that today have no solution because the problems have not yet been fully perceived (6) or adequately defined for computer analysis. Research of this type is essential to provide a constant stream of new concepts and techniques by means of which change may be controlled. As an example of a means of controlling change which is now feasible (it is currently used to facilitate stock exchange transactions, (16)), consider the operation of the type of development information system towards which we will shortly be forced to move but for which research techniques are at present inadequate.

Groups, organizations, foundations or individuals will register via a computer, perhaps anonymously, their interest in participating in programmes in a particular field. Any body willing to formulate, initiate, coordinate or finance such a programme, could at any time test the number, and perhaps type, of bodies which have registered such an interest. Proposals could then be circulated via a computer addressing system without the need to reveal the identity of recipients. The initiator would then receive replies from those interested in his proposals, permitting him to prepare a preliminary meeting to launch the project.

Any programme coordinators for general programmes could automatically monitor the current and proposed (non-restricted) projects in any specialized area and thus ensure that the specialized project coordinators received all appropriate information on the general or related specialized programmes with which they could align their activities or from which they could obtain support.

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Visual display units would provide immediate access to a general picture of the pattern of change and would automatically signal areas of imbalance (including unchecked control) detected by standard and new experimental techniques.

Such a system could operate through an international network of computers serving remote terminals. It would ensure continuous dynamic interaction between change agents and signal all reas in which participation or support was required. The instantaneous display of areas of imbalance would facilitate rapid organized response. A dynamic system of this kind would require a very flexible and organic, perhaps even continuous, reconceptualization of the world system and the relationship between the entities in its many sub-systems.

In the early stages, such an information system could operate by postal contact with the central computer and gradually switch over to remote terminal, real time processing as this became economically justifiable. Regional computer systems could also be set up to handle local projects.

A sophisticated dynamic information system of this type could be quickly developed from the specialized information systems which are currently under investigation, provided that the eventual objective is clearly defined in the near future.

STUDY AND DISPLAY OF ORGANIZATIONAL NETWORK (see Fig. 3)

This section describes how a research worker or decision-maker could interact with a visual display unit linked to the type of data bank proposed and aided by some of the techniques outlined above.

a) Flowchart presentation of world system
The research worker could group organizations with certain characteristics into classes which interact in certain specified ways. By grouping organizations, an average of their characteristics and the characteristics of their interactions with organizations in other classes can be conveniently represented. Many flowcharts of the whole world system, or a part, can be obtained in this way. A flowchart can be complified to just one type of interaction (e.g. membership, information, policy) or may include several. The flowchart may be made complex by using many classes and interactions or simply by using only a limited number. The research worker can modify his definition of the classes or study the effects of increasing flows in some areas or creating flows in new areas. This technique is a valuable complement to simulation of world system operations.

b) Network presentation of world system
The research worker could portray the interaction between single organizations or parts of organizations in a network form. Since each type of interaction creates a different type of network, many networks can be superimposed or only one need be displayed. The research worker could also create his own set of networks directly with a light-pen on the screen.

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The network could also be structured in terms of some two or three dimensional coordinate system so that the significant organizations in terms of one definition are grouped in one area (e.g. policy formulating at top, policy implementing at bottom, or most coordinative near origin). The lines between the points representing organization interactions could be made longer, shorter, thicker, thinner or dashed according to interaction criteria defined to be of interest. This technique can be combined with a 'flashing' technique to draw attention to special links or nodes as a result of computer analysis of the network. These possibilities would considerably speed up evaluation and improvement of new methods of world system structure analysis such as Johan Galtung's suggestions for a "calculus of integration" (17).

The network could also be structured in terms of issues on the basis of certain assumptions. Cross-issue links could then be evaluated. Different types of organizations (as defined by the research worker) could be represented by different symbols on the display screen. Short life organizations, or bodies with a long activity cycle (e.g. large five-yearly congresses), could be made to flash with a characteristics periodicity thus giving some idea of the lack of continuinity of flow in some parts of the network.

c) Response curves and textual display (see Fig. 3M)
Using simulation techniques, stresses could be introduced into the network. The interaction characteristics of parts of the network would amplify or dampen such changes. This could best be followed by requesting response curves for critical parts of the network -- or the flowchart, if that form of grouped presentation is used.

The response curves could be placed on a specially defined part of the display area. Such an area could also be used for the display or request of textual descriptions or analytical results pertaining to different parts of the network indicated by the researcher using the light-pen.

Response curves might be used to show the probability of information disseminated by node A reaching node F according to certain assumptions made by the researcher about the factors governing such flows. Similar curves might be displayed for the collection by node A of information from nodes B to F. Other curves might be used to show the probability of the alignment of programmes of low-level organization with the recommendations formulated by high-level organizations. Conversely curves could be displayed on the basis of certain assumptions to show the probability of the response by high-level organizations to resoltutions passed on by low-level organizations. There are many other possibilities of this type.

The research worker also has the possibility of attempting an optimization of the organizational network. By modifying organizational characteristics (as they would probably be modified as the result of new funds or higher-level policy recommendations, etc.), he can iterate toward the optimum organizational structure in a particular area. Such analyses could only be of value if adequate allowance was made for the valid resistance of some

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organizations to recommendations based on such calculations. A representation of informal structures would be required.

Recommendations arising from the use of such techniques could be used as a guide by decision-makers. The educational value of a display system of the type proposed could be used to support and explain any decisions based on such techniques. These techniques would be particularly useful as a guide to any decisions regarding the creation of new organizations, meeting series or programmes. They would help to indicate, for the type of organization proposed, the likely performance to be expected.

Communications and Education Research (see Fig. 3L)

A visual display unit has considerable advantages as a technique for the communication of new concepts. As the world system increases in complexity new techniques must be sought to simplify education concerning it and the many roles and interactions open to the individual, the citizen and his organizations. The problems posed by the time currently required to communicate an adequate working knowledge of the world system and the difficulty of building up an integrated picture of its complexity, suggest that a visual display unit may have many possibilities.

An important technique in building understanding is the ability of a display unit, linked to the type of data bank proposed, to portray the world system organizational network from an origin chosen anywhere within the network. Thus an organization, known and understood by a particular user, may be used as visual origin and all other organizations displayed in terms of their relationship to it. Organizations "distant" in communication terms can be reduced in visual importance, whereas "nearby" organizations of relatively little absolute importance can be made to appear of great significance (approximating the recognition normally accorded to it by the user). This technique has considerable psychological value. The student has a known base or organizational environment from which to start his exploration of the organizational network. He is able to understand how his known organizations are "nested" within an organizational environment. He can work from this base by requesting a resturcturing of the network in terms of other organizational viewpoints as he builds up knowlege of, and a "feel" for, those originally conceptually distant from his starting point. Text can be displayed concerning the new organization, interaction or perspective before any new 'jump' is made. In this way he can progress toward the more general levels of the world system or into other areas of detail.

Clearly, since a 360° view of the network cannot be supplied, the student must specify the direction in which he wishes to observe the network. He can then rotate his effective "field of vision" around his pre-specified viewpoint in order to locate the next organizational viewpoint about which he wishes to learn or in terms of which he wishes to restructure the network. The significance of this possibility is that it would enable a person to understand the organization/information environment of groups with which he has not previously been in contact.

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A valuable feature of an interactive system is the possibility given to a student of simulating the result on the world system of "wiping out" a single organization or a class of organizations believed to be of little value. Students can experiment with the system by "moving around" within it, modifying it to fit preconceptions or rigid definitions and observe their operational results, or observing the system as a whole in various projections. At any stage, textual material could be requested by the student. Such a technique could be adapted to use in the learning process by school or university students, adult education classes or the briefing of diplomats, delegates or specialists who are to be exposed to other viewpoints or conceptions of the organizational environment. Clearly low-cost, video, non-interactive versions of an educational sequence could be prepared and reproduced for wider distribution.

SYSTEMS AND HARDWARE REQUIREMENTS

The proposed data bank could be organized in a number of ways. If the research processing requirements are minimized (and possibly handled via a preliminary restructuring operation), then conventional file structures can be used. If it is considered useful to avoid a restructuring operation and to facilitate complex research, then the organization of the file raises problems of timing and memory space.

If the proposed data bank can only be implemented with a minimum of financial backing from sources uninterested in the sophisticated research possibilities, it would be an advantage to use programmes and file descriptions which can be subsequently increased in sophistication. In this way, the minimum data on coded entities could be included initially and more detailed descriptions added subsequently over a number of stages. Sophisticated processing would thus be possible in some areas before others depending on the priorities established for data collection (whether detail or coverage).

This possibility requires that the final form of the file and the specific research requirements should be known at an early stage to minimize the possibility of structuring the file in a non-optimum manner at any particular stage.

The more sophisticated processing possibilities implied by some sections of this note, whilst currently feasible in isolation or on small files, may pose considerable problems of memory requirements and processing delays when used together on large files. Detailed study and a clear definition of requirements may, however, indicate means of avoiding these difficulties.

Another approach appears to be possible, however, which would facilitate rather than create obstacles to the integrative emphasis which it is intended that the system should stress. This approach arises from recent work by Gordon Hyde, Scientific Director of Datatrac Ltd (U.K.) on new conceptions of information retrieval systems. He consideres that: "Most existing information retrieval systems depend to a large extent on uneconomic use of numerical processing machines.Where attempts have been made on more difficult information retrieval problems, they have usually been confined to highly constrained, statistically

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well-defined areas of subject matter and static uniterm data bases, whereas the real information retrieval environment is statistically indeterminate, dynamic and formally more than finite. With regard to software approaches, although considerable advances have been made in heuristic programming, its strategies are costly, time-consuming, make heavy demands on skilled personnel in short supply and still leave the specific problems of information retrieval unresolved." (10).

He points out that only recently (Royal Society Discussion, 18 October 1968) has a specific information processing machine been seriously considered. His work has been on the theoretical basis for such a computer which has to be mathematically unlike numerical processing machines. He consideres that: "Numerical analysis and statistics allow us to analyse, measure and to some extent understand and control randomness artificially, but if our goal is synthesis and unification, we must turn to intuitionist group theoretical methods as the theoretical physicists have shown" (11). It is precisly this attitude which may prove essential to an adequate understanding of the complexity of the world system. The key to this approach is the conclusion that "non-Abelian (non-commutative and partially non-associative) coding procedures" are required. This work has been extended to "the possibility of a universal binary meta language, which has hitherto been regarded somewhat as the philosophers stone of computer science." He considers that "For the first time therefore, we have a means of automatically addressing and retrieving combinatory propositions from a formally more than finite information space. We also have the capability of organizing that space in a variety of modes for optimization of storage parameters and retrieval strategy. Several workers can even work the same data base in different retrieval modes." This is precisely what the processing possibilities mentioned earlier would require. He continues: "It is clear that the operations can be used for naming, classifying and identifying any digital sequence, including non-scalar and non-linear sequences such as occur in pattern recognition. It is also clear that the system can be used for addressing and handling mutli-dimensional matrices with many variables, such as occur in linear programming." (10). Gordon Hyde has specific proposals for the creation of the requisite new hardware and is discussing the early adaptation of existing hardware by the incorporation of existing encapsulated logic circuits. With a "not unduly costly" (11) modification of this type, he describes the processing capability as follows. "Supplementary to the addressing structure on a single level, large groupings, hierarchies, tree-structures, porisms, and multi-dimensional networks can be constructed within the total universal binary metalanguage symbol space. Recursive coding from natural language input can be placed against higher order addressing....The vast theoretical information space, open file addressing capability, and the possibility of address linkage both along and across the symbol space, should permit an approximation to the human learning function hitherto unattainable" (emphasis added) (10). "It is claimed that the device, in addition to optimizing storage and addressing parameters in large scale real-time computer systems, will also considerably simplify programmes, and retrieval strategies in areas of application which present heuristic and combinatory problems for existing systems, including

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retrieval by syntactic and propositional statements in natural language, nested and multiple cross-indexed data bases, retrieval of product information by specification coding and linguistic applications." (12) Visual display units with graphic capabilities are highly suited to this type of system.

CONCLUSION

This note has stressed the advantages to research workers to be derived from the creation of the proposed computer-based information centre. Most of the techniques have already been applied in the physical sciences and engineering. The problem remains to adapt them to the less easily quantifiable variables encountered in the political, social, management and information sciences which are essential to an adequate analysis of the world system.

Use of the above techniques should make it possible to move quickly to a stage where there is an interaction between techniques and their adaptation to the available equipment which permits progressively more rapid and sophisticated analyses as well as an increasing "spin-off" to assist practical decision-making. Some features could be quickly available at a low, but useful, level of sophistication. It is however essential to recognize the possibility of gradually and flexibly increasing sophistication as techniques improve and funds become available.

RECOMMENDATIONS

The formulation of recommendations can best be based upon those produced as a result of the broadest and most recent published approach to the communication problem, namely the SATCOM report. The Committee on Scientific and Technical Communications (SATCOM) of the National Academy of Sciences/National Academy of Engineering (U.S.A.) had as its three major objectives (Feb. 1966):

- "To gain a comprehensive overview of the current state and required evolution of scientific and technical communication."
- "To stimulate increased participation among individuals and institutions in national planning for the improvement of scientific and technical communication."
- "To function as a forum and clearing-house on currently acute issues relevant to scientific and technical communication."

It recommended (June 1969) the establishment of a permanent Joint Commission on Scientific and Technical Communication responsible to N.A.S./N.A.E.

"The Commission is to be conversant with activities in scientific and technical communication and to provide guidance useful to public and private organizations in the development of more effective scientific and technical communication. It also should be responsible for leading the private sector in the coordination of its interests and programs and in the development of broad and farsighted plans. Therefore, its mission should entail:

1. Serving the scientific and technical community by fostering coordination and consolidation of its interests in the handling of scientific and technical information.

2. Serving the government by providing representatively comprehensive and authoritative information and advice on the activities, needs, and ideas of the scientific and technical community in this field.

To fulfill this mission, the Commission should identify needs and requirements and actively stimulate efforts to explore appropriate arrangements for cooperation and coordination. It must review and contribute to the broad planning of scientific-and-technical-information activities and would expect to assist the federal government in building and adapting a framework of policy for the effective operation of scientific and technical communication. It also would provide a forum for the timely and broad-gauged review of current acute issues.

In recent years, increasingly effective organizational mechanisms have fulfilled these functions in relation to the scientific and technical information-handling efforts of federal agencies. However, no effective mechanism exists at the present time for facilitating interaction between the government structure and the activities of private organizations — both those for profit and those not for profit — in this field. The emergence of a coordinating institution of broad scope and representation in the private sector is necessary for the development of such interaction. To fulfill this role will be one of the primary objectives of the proposed Commission

The extreme complexity of the entire scientific-and-technical-communication system is such as to expose it today, and with increasing severity tomorrow, to the unforeseen disruptions and crises so characteristic of large aggregates of activities, the interdependence of which is not fully understood and which are not well-coordinated. Some crises already are upon us (e.g. the page-charge issue); others lie ahead. They will require continuing efforts on the part of the Commission.....

Another problem that we consider of comparable importance is the development of a substantially more coherent pattern of cooperation among the many and diverse secondary information services. Efforts to develop such a coordinated pattern involve not only subtle technical problems, especially in regard to standards and convertibility, but require the establishment of realistic pricing and funding policies for such services.....

Another area for Commission attention pertains to the way in which the opportunities for innovation afforded by advanced technology might be explored. The Commission should urge the priority of large-scale experiments and the participation of qualified scientists, engineers, and practitioners in these efforts. Further, it should foster the application of the results of such experiments in contexts other than the particular ones in which they are obtained.....

Effective liaison must be maintained, especially with federal agencies, and special efforts will be necessary to ensure that current concerns receive thorough airing from the respective viewpoints of the government's requirements and the capabilities of private organizations — viewpoints that hopefully will become less and less often at odds with one another.

Commission membership should include as broad a representation as feasible of the major scientific and technical communities and the principal kinds of organizations engaged in related information-handling activities, as well as representatives of the Councils of the National Academies and liaison members from the principal government activities. Such coverage could be provided by a membership of about 20. Additionally, the Commission should continue to draw upon the advice and assistance of the nearly 200 Consulting Correspondents whom SATCOM has assembled.....

The Commission could be especially helpful in suggesting directions and setting priorities for new efforts in research and exploratory innovation. To do so, it would need to develop a basic conceptual framework for the evolving pattern of scientific and technical communication from which to derive guidelines for future efforts and criteria for appraising current ones." (pp. 276-280; emphasis added)

Specific Recommendations

On the above basis and bearing in mind the arguments developed in this report for a comprehensive approach, specific recommendations are:

1. The creation of a study group to define the scope of the whole communication problem in the light of the requirements of a general systems approach.

2. The creation, on the basis of the conclusions of the work of this study group, of a commission with a mandate similar to that of SATCOM (except that the explicit restrictions to the field of U.S.A. science and technology and the implicit restrictions to a narrowly defined systems approach should be removed). A major objective of this commission should be to determine the structure of a body to perform, at the international level and for all subject areas, functions similar to those recommended by SATCOM for the Joint Commission.

3. The establishment of a permanent international body structured, in the light of the SATCOM philosophy, to reflect the communication concerns of governmental organizations, private non-profit and for-profit organizations, the various academic communities and the many practitioners and information users not otherwise represented.

4. As an aid to, and in parallel with, the activity of each of these bodies in turn, the establishment of an international computer-based information centre on international and national organizations and related entities using a network file structure. A specific task of this centre should be to facilitate systematic analysis of information flow within the world system to increase the precision, and justify and clarify the recommendations of the above bodies. A major concern should be to ensure that such a system is used by both academic research groups and practitioners of all types needing contact-information or assistance. Such a centre could advantageously be based on the current data processing activities of the Union of International Associations, Brussels.

5. The various study commissions and the permanent body should ensure the continuing investigation of the need for and manner by which the file structure, size, coverage and conception of the computer-based centre should be developed, in order to work towards the more sophisticated data processing opportunities and benefits outlined in this report, as well as the many others likely to result from integrated research into comprehensive man-machine systems.

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Design and analysis of electronic circuits. IBM file no. 360D-16.4.001

Graphical electronic circuit analysis program. IBM file no. 360D-16.4.002

Electronic circuit analysis for design and optimization of complex circuits. IBM file no. 360D-16.4.007

Kinetic simulation language for chemistry and biochemistry. IBM file no. 360D-03.2.008

IBM System 360 Operating System; graphic subroutine package. IBM file no. 360S-LM-537

IBM System 360 Operating System; graphic programming services for Fortran IV IBM Reference Library Manual no. C27-6932-1

IBM System 360 Operating System; graphic programming serives -- basic IBM Reference Library Manual no. C27-6912

ype	Member	Tax state	Aims	Govt.	Org. of int.orgs	Int.org	Region. int.org	Bilat. int.org	Org. of nat.orgs	Nat.org	Territ. nat.org	Region. nat.org	State/ cty.org	Local/ com.org	Famly	Indiv.
on-rg.					(Attitudes, belief systems, traditions)											
n-formal					(Mvts. of opinion, invisible colleges, pressure groups, groups, gangs, cliques)											
Semi-formal					(Nongovt. conferences, meetings, symposia, group meetings)											
					(Govt. conferences, meetings, symposia, group meetings)											
					(Business conferences, meetings, symposia, group meetings)											
					(Nongovt. programs, campaigns, projects, ad hoc bodies)											
					(Govt. programs, campaigns, projects, ad hoc bodies)											
					(Business programs, campaigns, projects, ad hoc bodies)											
ormal	V1	C1		NG1	(Religions, religious orders, cults, sects, communities, secret societies)											
	V2	C2 C1	NP1	NG2	Org. of int.NGOs	Int.NGO	Region. int.NGO	Bilat. int.NGO	Org. of int.NGOs	Nat.NGO	Territ. nat.NGO	Region. nat.NGO	State/ cty.NGO	Local/ com.NGO		
	V1	NC			(Professional organizations)											
					(Trade and workers unions)											
	V3		NP2		(Trade associations, chambers of commerce, commodity exchanges)											
	V1		NP1	NG3	(Political parties and organizations)											
	V3	C1	NP3	NG4	(Research and educational institutes, universities)											
		NC	NP4		('Not-for-profit' research institutes, 'think tanks')											
		C1	NP1	NG2	(Foundations)											
					(Trusts, funds)											
			NP3	NG5	(Cooperative retail and producer societies, communes, kibbutzim)											
	V2			NG2	(Clubs)											
	V3		NP5	G1	Org. of int.IGOs	IGOs	Region. IGOs	Bilat. IGOs	Nat.govt	Govt. agency	Territ. agency	Region. govt.ag	State govt.	Local govt.		
			NP1	G2	(Technical IGOs)											
	V1	NC		G3	(Quasi-governmental, 'independent' govt. commissions)											
	V3		P1	G4	(IGO corporations)			(Nationalized industries)			(Govt.enterprises)					
			P2	NG6	(Multinational enterprises)				(Industry,trade,finance, manuf., service)					Firms		
				NG7	(International cartels)				(Cartels and other arrangements)							
			Mixed organiz.		(Joint NGO-business organizations)											
					(Joint NGO-govt. organizations)											
					(Joint Govt.-business organizations)											
	Ascrip.	C1	NP3	G5	(Hospitals, asylums, rehabilitation centres, prisons)											
					(Armies, tribes, clans)											
on-rg.				G1	(Intergovt. treaties/agreements)				(National law)		(State law)		(Local law)			
				NG6	(Business contracts)											
				NG2	(Working agreements)											
					(Information systems: governmental, business, interest group)											

FIG. 1 TENTATIVE COMPREHENSIVE GROUPING OF ORGANIZATIONAL FEATURES OF WORLD SYSTEM

(Key: V = voluntary; C = charitable; P = profit; G = governmental; N = non-; detailed key in Fig. 1a)

FIG. 1a DETAILED KEY TO FIG. 1

Fig. 1 represents an attempt to merge a number of categories isolated by a variety of academic disciplines and bodies interested in different aspects of the world system. The overlapping and grey areas between categories, illustrated by the detailed key below, highlights some of the inadequacies of current terminology in providing a common framework for discussion concerning aspects of the world system. Similar problems are experienced when using the categories 'international', 'regional', 'national', etc. (see: Judge, A.J.N. Classification of organizations within the world system. Brussels, UAI, 1968)

V1	voluntary membership although generally distinguished from V2. Volunteering may only be possible after invitation. Socio-economic pressures may be used.
V2	mainly volunteers involved. 'Voluntary' organizations.
V3	voluntary only as opposed to ascriptive. Membership by employment.
C1	charitable as approved from country to country by tax regulations
C2	charitable in broad sense as being not-for-profit
NP1	nonprofit and probably recognized as such by tax authorities
NP2	nonprofit but may be considered as 'profit' because of member interest
NP3	nonprofit but may be 'profit' in nonsocialist countries
NP4	nonprofit only in the sense that profits are not redistributed
NP5	nonprofit in case of some agencies, but the governmental complex may attempt to balance the flow of funds to, in effect, make a 'profit'
P1	profit, but strongly influenced by 'non-profit criteria'
P2	profit, but may be strongly influenced by 'non-profit' criteria in large or complex organizations
NG1	nongovernmental, except possibly in case of state religion hierarchies. Generally distinguished from NG2
NG2	nongovernmental, except where closely connected with state apparatus or directly financed from government funds. Government officials may be members of such organizations in their official capacity.
NG3	as for NG2, but may have a special relationship with the government
NG4	nongovernmental, but may be partially or wholly, directly or indirectly, controlled by government
NG5	nongovernmental, but may have a special relationship to government in socialist countries
NG6	nongovernmental, but government may have effective control as majority shareholder or by the manner in which contracts are allocated
NG7	nongovernmental, possibly illegal although government may be indirectly supporting the conditions giving rise to such bodies
G1	governmental, in the sense of policy making or administration of policies
G2	governmental, but primarily concerned with coordination and exchange of information on technical matters
G3	government appointed 'independent' bodies reporting back to government
G4	governmental, but possibly with such autonomy as to be 'nongovernmental'
G5	usually governmental, possibly nongovernmental in some nonsocialist states

The deceptiveness of conventional categories may also be illustrated by the following: (a) non-independent territories may be members of IGOs; (b) regional, national and local NGOs may be members (of equal standing) of international NGOs; (c) an international NGO may be a member of a national NGO; (d) the 'degree of organization' of a regular annual cycle of meetings, or a program, may be greater than that of a formal organization; (e) national or local bodies, or an information system, may be of greater international 'significance' than the international body, if any, in the same field; (f) the state apparatus may be so thoroughly penetrated by private or foreign interest pressure groups that the concept of its independent existence loses meaning.

FIG. 1b UNBALANCED RESEARCH COVERAGE OF THE WORLD SYSTEM AND SUB-SYSTEMS

A. Research studies in organizational behaviour

Bertram M. Gross (U.S.A.) has published the results of a survey obtained by searching the published literature of sociology, anthropology, psychology, economics, political science, public administration, and business administration. This includes a canvass of most English-language professional journals in these fields from 1940 through 1962

Organizational Type	Articles	Books	Total	%
Business (excluding research)				
goods	114	42	156	
services	28	12	40	
outside U.S.A.	27	9	36	
totals	169	63	232	40
Government (excluding education, health, research)				
central coordination	3	7	10	
military	42	9	51	
civilian	42	27	69	
outside U.S.A.	9	3	12	
.... international	3	1	4	
totals	99	47	146	25
Public service				
education	18	6	24	
health	48	10	58	
social work	3	2	5	
totals	69	18	87	15
Associations				
trade unions	28	10	38	
political action	13	9	22	
trade and professional	0	2	2	
fraternal, cultural	5	1	6	
religious	2	2	4	
cooperatives	3	2	5	
totals	51	26	77	14
Research	17	5	22	4
.... Cross-type comparisons	11	1	12	2
Grand totals	416	160	576	100%

(GROSS, B.M. Organizations and their managing (condensed edition of The Managing of Organizations). New York, Free Press, 1968, p. 636)

B. Research on international organizations

Chadwick F. Alger (U.S.A.) has published the results of a systematic survey of 14 journals and 10 international relations readers (1960-69)

Organization Type	Number of Studies	%
United Nations	35	66
UN and other IGO	2	3
Other IGO	10	16
NGO	3	7
IGO/NGO	3	7
International business organization	0	0
	63	99%

Fig. 1b(contd.)

To bring out the significance of the above figures and the conclusions drawn from them, the following estimates of the numbers of each type of body (from the 1968-1969 edition of the Yearbook of International Organizations) are given:

United Nations (1), U.N. Agencies (27)
Intergovernmental organizations (201)
International business organizations (2819)
International nonprofit organizations (2577)

No survey of the total number of national bodies and local bodies in the world system appears to have been made or proposed. Author's 'guestimate' is 0.5-2.0 million

Other results and some conclusions drawn by Chadwick Alger may be summarized as follows(*):

- "Despite an increase of 64 per cent in the number of international organizations between 1956-57 and 1962-63, there has been a decline in the research published on international organizations..."
- "The amount of published works on international organizations utilizing quantitative and field research techniques has remained rather constant."

An analysis of 53 works that have employed these techniques reveals the following:

- "Forty-one (71%) study only one organization, and only four reveal comparative work on the inner workings of international organizations."
- "None of the studies focuses on relations between organizations."
- "Thirty-five works (66%) study the United Nations, with only studies of patterns of membership of the entire family of IGO and/or INGO extending beyond the UN family and European organizations."
- "There are no studies of international business organizations."
- 62% of the works are concerned with voting, voting studies and research on attitudes and beliefs
- "Little intrinsic interest is demonstrated in the specific problems of international organization agendas..."
- "...twelve studies (23%) indicate a basic interest in integration."
- "The low and declining attention paid to international organizations by the journals surveyed, in the light of phenomenal growth in the number of international organizations, raises questions about the responsiveness of research to this domain of human behavior....data gathered in preparing this paper suggest that published research is exceedingly unresponsive to some fundamental changes in man's transnational behavior."
- "The farflung experimentation taking place in building international organizations is not being adequately sampled and exploited as a source of use in constructing organizations that more effectively satisfy human needs."
- The "overwhelming attention given to the United Nations" is understandable, but this dependence on a sample of one is contrary to the "commonly shared goal...the development of general theory" and "suggests that too much of available resources have been devoted to United Nations research."
- "...considering the exciting advances...in comparative methods in political analysis, the slight effect this has had on research in international organizations is surprising."

(ALGER, C.F. Research on research: a decade of quantitative and field research on international organizations. Paper presented to American Political Science Association annual meeting, September 1969)

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* The absence of (a) research on local, national and international organizations considered within a common framework, (b) interaction with world system studies in other disciplines, is not brought out by this survey.

FIG. 2 ANALYSIS OF INTER-ENTITY NETWORKS

A. Ideal gas theory versus the network theory: citation indexing

Network theory is a highly specialized branch of mathematics. Its applications to date have been mainly in narrowly defined technical problem areas. The one exception noted is the use of network theory to develop the concept of citation indexing which has now seen practical application for some years in the Science Citation Index developed by the Institute for Scientific Information (U.S.A.). Eugene Garfield, who has been intimately involved in the development of citation indexing, uses the following argument in its favour:

"The traditional philosophy of indexing system design implies that individual documents can be treated as though they were independent entities. This basic fallacy not only results in the loss of important informational links, but it is basically inefficient. This is illustrated by the example of the identical document published in two different journals. The same indexing procedure will be followed for "both" papers as though they were two entirely different documents. The indexers would select subject headings to describe the "main theme" of each paper. In practice, we know this does not occur consistently even for the same indexer. Little or no effort is made to establish a possible relationship between the document being indexed and the documents already indexed in the collection. There are exceptions to this rule, but generally the building-block development of human knowledge is not perceptibly reflected in traditional indexing systems....In conventional word indexing systems, the indexer cannot afford the time to establish...linkages between concepts. He treats the literature as a series of independent events, like molecules of gas....But the literature is not an"ideal gas". Libraries consist of collections of highly interrelated documents. The literature is a heavily cross-linked network. The clearly visible linkages are those ordinarily provided by authors in the forms of explicit citations. Less clearly seen are implicit references as in eponyms and neologisms. Almost invisible linkages exist in the natural language expressions which obscure the relationships, especially to the unskilled observer.

"Conventional bibliography is essentially a simple listing or inventory of publications which disregards most of the interrelationships between the items in the inventory. In contrast, citation indexing integrates this necessary and useful listing in a huge graph or network. In this graph, each document is a node or vertex in a huge multi-dimensional network. By analogy, this model of the literature (man's knowledge) is like a large road map in which the cities and towns share varying degrees of connectivity. Even the smallest hamlets are nodes on the citation map of science.....

"When conducting a literature search...(the library patron of the future)... will receive not only a conventional bibliography, but also suitable notations for each item indicating the interrelationship with other items in the bibliography. In addition, he will receive a graph which shows these relationships more clearly. The graph will be drawn by a plotting device attached to the computer or displayed on a TV tube. For a short bibliography, this can be done with relatively inexpensive equipment. In fact, a useful map could be prepared by a conventional typewriter or line printer...This is very similar to the computer methods used in drawing PERT diagrams."

(GARFIELD, Eugene. Primordial concepts, citation indexing, and historio-bibliography. Journal of Library History, 2 (3), 235-249 (1967); based on a talk at a symposium, Proceedings of symposium on the foundations of access to knowledge. Syracuse, University School of Library Science, 1965)

Fig. 2(contd.)

B. Extension of the network concept to other entities

Eugene Garfield's argument refers only to the treatment of documents and to the field of science. An adequate picture of the world system can clearly not be limited merely to what appears in documents. The producers of documents, as well as non-producing bodies may have many other types of contact with one another, with each type of contact resulting in a new network. This complex of links between entities is just as significant for an understanding of the world system as are citation networks for effective document retrieval and an understanding of the development of man's knowledge.

The argument in the previous section can therefore be extended, mutatis mutandis, to apply to the classical (ideal gas) theory of organizations as independent entities ('billiard balls'), as opposed to the systems approach emphasizing the multi-dimensional network of relationships or links between such entities. The argument then applies to the producers of knowledge rather than the knowledge produced. The network nodes thus include dynamic entities which respond to change, as opposed to the static unchanging products of their activity, which are of considerably less significance for the control of change or the development of knowledge and its use. As pointed out in the main report, this change of focus considerably reduces the volume of information to be handled*(and therefore the cost), thus rendering a comprehensive, multidisciplinary, multipurpose, international information system a practical and useful proposition — from which a large variety of static network information systems could be developed as and when convenient.

One interesting trend in this direction are the current experiments on evolutionary indexing described in the 1969 SATCOM report as follows: "More exciting than retrieval of information from a static store is evolutionary indexing, in which users' additions, modifications, restructuring, and critical commentaries steadily improve the initial indexing of a collection and not only provide more efficient access for subsequent users, but constitute a significant step in the evaluation and consolidation of primary information."

(Committee on Scientific and Technical Communication (SATCOM). Scientific and technical communication; a pressing national problem and recommendations for its solution. Washington, National Academy of Sciences, 1969)

In arguing for a network approach, the distinction between (a) a network approach to the manner in which information on information producers is structured at a single centre and (b) a network of geographically distant but interlinked information centres, must be stressed. Although there may be some theoretical similarity and the two approaches may even be combined, the second approach is ambitious, costly and beset with political and jurisdictional problems. The SATCOM report has the following to say about the second approach:

"The concept of interconnecting structured files of documents and data ranging in scope from the local to the regional, national, or international level has been advocated for some time as a prime objective in coping with the rising tide of information and the more pressing and diverse information needs of scientists and technologists. Thus, in reviewing developments in this area, Swanson (R.W. Information system network...let's profit from what we know. AFOSR 66-0873. Washington, U.S. Office of Space Research, 1966) states: 'It is no longer necessary...to ask whether networks can be built. It is time, instead, to ask about the sorts of networks that are needed, and to set about providing the innovative software and the flexible, inexpensive hardware to bring them into being.'.....Current tendencies in government, industry, libraries, universities, and scientific and technical societies toward the operation and development of information networks lend support to these assessments of the need for and potential advantages of network efforts."

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* The Institute for Scientific Information (Science Citation Index) will have processed 15 million reference records by the end of 1969.

But the SATCOM report then goes on to say "For some years to come, technical as well as economic constraints will limit the effective size of hand-tailored information services designed to function in close responsiveness, and with good feedback coupling, to their customers." In other words, such systems will only be able to the few and will only cover specialized domaines. The report continues "However, we anticipate the proliferation of such individual services in order to provide adequate coverage of the expanding scientific and technical literature and effective services to increasingly diversified user groups."

In other words, it would appear that they will be created very much on an 'as and when' basis, and when created will be user-group orientated in such a way as to actively prevent cross-disciplinary information retrieval. No conceptual or information framework to follow and recommend the development of each specialized system is considered necessary.

The SATCOM report is a most important document with many valuable conclusions, but it is an example of the current narrow approach to the communication problem. For example:

(a) it concentrates on science and technology despite the acknowledgement that "A third area requiring attention and appropriate action relates to the slowly knitting, massive, mission-oriented programs of recent years which deal with major social concerns, such as natural resources, education, transportation, pollution and urban problems. The role of science and technology in the resolution of these problems is not yet clear; therefore, the nature and scope of the information programs that they will require only gradually will become apparent. The policies and practices identified as essential for the effective operation of scientific and technical communication are particularly important in relation to this new range of national endeavors." This indicates an interest in the use of science and technology for other domaines, but there is no recognition of the importance, in their own right, of these domaines for society, or of the interaction between the hard-core science information networks and those of other fields of interest, or of the need in the field of science for feedback from such domaines to influence research priorities. The centre of gravity of the SATCOM is necessarily entirely in the scientific field. It is however possible that the requirements of non-scientific users, e.g. policy makers or academics, may introduce criteria which could modify the whole conception and philosophy of a useful future information system. There is however no framework within which investigation of the problem as a whole could be undertaken. The SATCOM report does not stress the need for such a framework or the information system to give it form.

(b) "The Committee agreed to make the publication, dissemination, and utilization of information on completed work the main subject of its study, to devote less attention to work in progress, and to exclude from its consideration the problems of handling information on planned programs of future activity." Although the Committee "regarded the scope of its survey as encompassing the entire series of organized activities involved in the transmission of information from early informal communication through formal publication, announcement in secondary media, and finally review and consolidation to adapt it to the working context of a potential user. Therefore, our survey focused chiefly on the efforts of people and functions of organizations rather than only on documents and documentation tools." (Such views are very poorly understood in documentation circles where the document is the basis of all discussion.) This approach nevertheless ignores a whole dimension of the communication problem. Unless information is available and well-structured on planned programs and future activity and integrated into the results of past activity, the information system is entirely oriented toward the past and largely useless as an aid to the solution of a major problem of the future, namely the balanced control of change. It also ignores the problem of resource allocation and that of the risk of duplication of research which has not yet been registered in the literature,

(c) in the repeated stress on the need for a systems approach to the communication problem the report assumes that the function of a future national or international information system is necessarily the more rapid and efficient transfer of information on documents or of information published or to be published in documents (whatever their form). As pointed out in the main body of this report, physical proximity to such information bears little relation to the feasibility of assimilating and using it even if it is highly relevant, and this problem is likely to get worse as the amount of information and the degree of specialization increase. This factor, and others like it, need to be considered when defining the criteria for a systems approach. An information system which sets as its goal the more rapid circulation of arguments and data (which are reworked, repeated and republished as each author in the field, or in related fields, responds to the currently fashionable approach), rather than one which attempts to focus on, register and signal the actual change in the body of knowledge occasioned by each new event, is surely doomed to ineffectiveness in the face of the rising tide of information, the variety of backgrounds and languages of those who need to know about and use the information, and the variety of purposes for which the information must be used. The report does not appear to stress the need for research on the access to knowledge or to mention the implications of the expected breakthrough in memory coding.

It would almost appear, despite many indications to the contrary, that the report does not recognize the possible impact of technological change on the information system which is created. In a period of very rapid change it is important to remain flexible. The information system envisaged (and which will be partially planned on the basis of views expressed in the report) will necessarily have many costly (and therefore hard to change), non-flexible features built into the logics of its different sub-systems, as each user-group can get funds allocated for an information system organized for maximum response to its narrowly defined area of interest. As the report says "all too often appalling errors in logical design still creep into schemes for the manipulation of large files. What is needed now in this area is not so much standardization as insight". A simple and relatively low-cost technique to guarantee flexibility is to ensure that the producer/users of information are linked through a network file structure, organized for rapid response to change (or crisis) in problem priorities, and which would permit rapid creation of new information networks as the need or technology warrants.

Fig. 2(contd.)

C. The network approach and the systems approach

The problems of an integrated approach to the control, management or understanding of change are illustrated by the following extracts from a paper by R.L. Ackoff:

> "Although political scientists, economists, and sociologists have concerned themselves with organizational structure, there is as yet no organized body of theory or doctrine of practice on which a unified disciplinary or interdisciplinary applied-research activity can be based. As a consequence most studies of organizational structure, such as those leading to reorganization of a system, are generally done by managers or management consultants whose approach involves more art and common sense than science.....
>
> The effectiveness of an organization depends in part on its having 'the right information at the right place at the right time'. The study of organizational communication is in much the same stage of development as the study of organizational structure. It has no organized body of theory, but it has been developing a doctrine of practice.....
>
> As we have seen, there is a large group of disciplines and interdisciplines dedicated to studying various aspects of organized man-machine systems. The fact that the subject is so dissected leads to several residual problems. Suppose that an organizational problem is completely solvable by one of the disciplines we have considered. How is the manager who controls the system to know which one ? Or, for that matter, how is a practitioner of any one discipline to know in a particular case if another discipline is better equipped to handle the problem than is his ? It would be rare indeed if a representative of any one of these disciplines did not feel that his approach to a particular organizational problem would be very fruitful, if not the most fruitful.....
>
> In most problems involving organized man-machine systems each of the disciplines we have mentioned might make a significant improvement in the operations. But as systems analysts know, few of the problems that arise can adequately be handled within any one discipline. Such systems are not fundamentally mechanical, chemical, biological, psychological, social, economic, political, or ethical. These are merely different ways of looking at such systems. Complete understanding of such systems requires an integration of these perspectives. By integration I do not mean a synthesis of results obtained by independently conducted unidisciplinary studies, but rather results obtained from studies in the process of which disciplinary perspectives have been synthesized. The integration must come during not after, the performance of the research.
>
> We must stop acting as though nature were organized into disciplines in the same way that universities are. The division of labor along disciplinary lines is no longer an efficient one. In fact, it has become so inefficient that even some academic institutions have begun to acknowledge the fact."
>
> (ACKOFF, R.L. Systems, organizations, and interdisciplinary research. General systems yearbook, vol. 5 (1960), Society for General Systems Research, p. 1-8)

In arguing for a systems approach to the world system, it is important to recognize the lack of both theory and data. A useful system embodying a network conception should therefore not be organized around one theory but should instead be useful as a basis for a variety of disciplinary approaches. It should also not be dependent on particular categories of data or on categories which are difficult to quantify. On this last point

Fig. 2(contd.)

the network concept can be extended in the light of current theoretical arguments to an emphasis on 'process' rather than 'entities', as outlined in the following extract. It is doubtful whether this process approach could be given an adequate data framework of wide utility at this stage. "The greater part of current discussion of systems in sociology is embarrassingly naive and out of date in the light of modern systems research in other disciplines.....The kind of system we are interested in may be described generally as a complex of elements or components directly or indirectly related in a causal network, such that each component is related to at least some others in a more or less stable way within any particular period of time. The components may be relatively simple and stable, or complex and changing.....Organic and sociocultural systems are examples of "organized complexity". As we proceed up the various levels, the relations of parts become more flexible and the "structure" more fluid with process as the set of alternative behaviors open to the components increases....the interrelations characterizing higher levels come to depend more and more on the transmission of information — a principle fundamental to modern complex systems analysis...Though "information" is dependent on some physical base or energy flow, the energy component is entirely subordinate to the particular form or structure of variations that the physical base or flow may manifest....Thus, "information" is not a substance or concrete entity but rather a relationship between sets or ensembles of structured variety — to put it very generally. The implications of this shift from energy flow to information flow as a basis for the interrelations of components in higher level systems are of central importance in distinguishing the nature and behavioral capabilities of the latter, as against lower-level systems. Thus a minute amount of structured energy or matter from one component of a higher system is able to "trigger" selectively a large amount of activity or behavior in other components in the system, at the same time overcoming limitations of temporal and spatial proximity as well as availability of energy....The structure of the system becomes more and more "fluid" as it merges with process — the communication process which is its predominant feature.....Donald M. MacKay is one of the small number of systems theorists who have tackled the question of semantic information from the perspective of modern information theory...He begins by suggesting that so little progress is being made on the semantic side of information theory because of a failure to study the communicative process within a wide enough context to embrace, not only the channel and the nature of the signals flowing through it, but the terminal sender and receiver as goal-directed, self-adaptive systems."
(BUCKLEY, Walter. Sociology and modern systems theory; presenting a case for replacing outmoded models of society with a more viable and appropriate conceptual framework. Englewood-Cliffs, Prentice-Hall, 1967, pp. 7-48)

Despite the difficulty of giving a useful form to this conception, it nevertheless represents an exciting method of looking at the immediately-realisable, network-structured data base proposed in this report.

Just as the citation index ensures the interrelationship of two or more references to the same document, the network structure assists in the solution of the problems raised by R.L. Ackoff (above). Where different specialized departments of a large, complex organization, or a network of organizations, are all in contact with a single organization, its manager, or closely related departments (for different reasons), the special

Fig. 2 (contd.)

approaches each represents are juxtaposed within a common framework to facilitate an integrated approach to planning, decision-making and resource allocation. This can be extended, if problem areas are treated as one type of entity (in a problem network), to cover cases where a network of specialized organizations is concerned with a single problem or related problems. This then meets the need for a method of ensuring that corrective measures developed in one sphere do not, through lack of a bridging framework, ignore the possible consequences in a second or third sphere. This approach would appear to be vital to efforts directed towards balanced control of rapid change in a dynamic world system.(*)

D. Multi-network theory development problems

Most network theory applications appear to be restricted to cases where there is a single network, a single type of relationship between nodes, or possibly several networks independently linking the same nodes.

It would appear that to apply network theory satisfactorily to the case of the world system(and its sub-systems), where this is made up of different types of entity (nodes) with a variety of relationships or flows (links) between them, the problem must be conceived as one of a number of superimposed networks, such that conversion and transfer of the 'flows' from one network to another may take place at the nodes. In addition, 'losses' must be permitted in the transfer process and in the flow between nodes. So that, for example, an input of funds to the node may be partially converted to an output of goods, information or recommendations, etc., and other less conveniently quantifiable flows. Much interesting work remains to be done to adapt the precise concepts of network theory to the type and amount of data available on world system operation. This development work can however be beneficially carried out (and even conceived as an ongoing, integral part of the process) in parallel with use of the proposed system for more mundane or less sophisticated purposes. The best lead located for the detailed solution of the mathematical problems and their data processing implications is the work of Börje Langefors, of which a non-mathematical extract is given in Fig. 2a.

(*) An interesting, but unfortunate, aspect of any attempt to argue for a general or genuinely multidisciplinary approach to a problem is that no conceptual framework exists in which the merit of generality can be adequately evaluated. Using any specialized framework, a multidisciplinary argument can only appear as a "collage". To the extent that conceptual organization is paralleled and institutionalized in organizations, the argument has to be reduced to a unidisciplinary/one-department problem to be processable. It is an argument in favour of the network approach that the method by which such problems will be resolved in the not too distant future can already be envisaged. It is already possible using network processing to convert arguments framed in the language of and using the familiarly worded examples of one discipline into those of another at a higher or lower level of generality. This will have the practical consequence of automating the selection and assembly of the most suitable supporting arguments, texts and diagrams in the preparation of reports proposing change — according to the requirements, at each stage, of the channels by which they must be approved. When no equivalent *logically* developed texts could be supplied for the second discipline or viewpoint, an indication of the optimum *learning* path and texts for comprehension of the first (or related) discipline arguments could be output by computer — perhaps in a programmed learning mode.

FIG. 2a GENERAL AND SPECIAL PROPERTIES OF SYSTEMS PROBLEMS

Börje Langefors (Theoretical analysis of information systems. Lund, Studentlitteratur, 1966) argues for the use of systems theory to facilitate contact and collaboration between specialized bodies:
"A question that is often encountered in connection with systems work is whether a certain problem would best be handled by the specialists in its field or by people who are not very familiar with that field but do instead know the total system -- or even, on a still more general level, do not either know that system but are experts in basic systems design methods. The answer should be fairly obvious -- but is yet most often missed — a balanced cooperation between different groups is what gives the best promise of success....A basic problem of systems theory should actually be to find out the best way of subdividing the work between different groups of specialists. Experience appears to indicate that most of the groups involved tend to neglect the importance or the difficulty of the other peoples field....

On the other hand specialists within a field often ignore the fact that many of their problems are of a systems type and might well be better solved by methods known within other fields or within the area of general systems theory....As another example it is obvious to many mathematicians or information processing researchers that many of the intricate problems associated with medical diagnostics and treatment planning are of a very typical information processing type and are also very similar to much advanced engineering work....Contrary to this, most physicians, while admitting that electronic experts or computer programmers could help in making some progress toward automatization of routine parts of their work, seem to be completely convinced that no mathematician or information processing expert could do anything which could be of value in developing methods for part of the medical work.

What could be done to improve matters in this difficult but important problem of co-operation ? It seems that systems theory could do a lot by showing clearly how problem areas could be subdivided into subareas of which some are concerned with the general properties of structure involved, some concerned with the special properties of structure within the field, while some others are mainly concerned with the specific problems of meaning and property for that specific field only. This is one of the most basic objectives of all systems design -- to define subsystems in a proper way and to take advantage of such subsystem definition."(pp. 35-36)

The two volume work elaborates both the theoretical implications and the data processing problems of this approach to systems design. In a "Sketch of a basic theory of systems analysis", 3 Propositions and 11 Theorems are set out which merit a wider audience amongst persons designing information systems or studying the world system. He has grasped a number of 'nettles', previously not considered objectively, and ordered the resultant problems and their implications for the conceptualization and design of information systems:

Prop. 1: People tend to neglect the importance or the existence of things they are not able to see or perceive.

Th. 1: People tend to underestimate the complexity of an imperceivable system. i.e. the number of parts and relations it contains.

Def. 1: An imperceivable system is such that the number of its parts and their interrelations is so high that all its structure cannot be safely perceived or observed at one and the same time. (cf. Main report argument for the importance of graphics for world system study)

FIG. 2b DIMENSIONS OF COMMUNICATION BREAKDOWN

In order to facilitate arguments about change and its control, their is great need for a technique which could unambiguously highlight the relationships and differences between problems and between assumptions. This could be done quite empirically by coding from published texts or permitting a wide variety of people to feed views and counterviews into a network coded system (cf. SATCOM report and evolutionary indexing Fig. 2 p. 2). The network cross-referencing of views and counterviews maintained on a continuing basis would "position" each viewpoint in a multidimensional "information space" and move it, over time, with respect to the "centre of gravity" of the currently held group of related viewpoints.

Clearly the longer the distances between points in such an information space, the greater the probability of communication breakdown As a conceptual/ theoretical aid to understanding an empirically developed information space computer system, a systematic classification of dimension along which communication can break down is required. Below is given a tentative list of dimensions. The focus placed by persons to widely separate points on any dimension appears to result in the creation of distinct groups as organizations. Conversely, differences between the emphasis given by entities to points along any of these domensions or to different dimensions would appear to lead to partial or total communication breakdown between them.

Clearly this list could only be validated and refined by thorough investigation of a wide variety of organizations within the world system. This validation process could however be carried on in parallel with the empirical coding process advocated above. The list contains inconsistencies, duplication and distortions and oversimplifications because no adequate conceptual context appears to have been developed to relate the diversity of human standpoints. The only attempt at this, a general analysis of "axes of bias", is reported in the poorly titled study by JONES, W.T. (The romantic syndrome; toward a new method in cultural anthroplogy and history of ideas. The Hague, Martinus Nijhoff, 1961). But no general study has been undertaken on "problems", system malfunction in the most general sense, or the possibility of a problem hierarchy, or the relationship of problems, assumptions, viewpoints, institutionalization and communication breakdown.

A developed list of this type would constitute an approximation to the framework of function space. It should provide a checklist for assumptions made in deciding upon or explaining any course of action. It should therefore be of value to an evaluation of the analysis of any subsystem of the world system. It is possible that a critical ratio range of measures of one dimension to those on others could be determined. Unbalanced ratios could then signal metastable situations likely to give rise to problems. This could give a lead to the development of a problem hierarchy of system malfunction.

Maximum value will be derived from a computer based information system on the world system when organizations and decision-makers can be "spread" along these dimensions and a measure of their "viewpoint mobility" or "communication inertia" determined. The U.S.A. National Academy of Sciences Committee on Scientific and Technical Communication (SATCOM) report recommends a related approach as follows: "...appropriate organizations should initiate and carry out comprehensive analyses of and experiments on the functioning of the different parts of the network of scientific and technical communication as well as of the network as a whole. It should be a long term policy to provide adequate funds for such studies...(which)...will have to deal realistically with many elusive factors —

Fig. 2b(contd.)

for example, inertia in behavior patterns and its effect on the acceptance of new services or the interrelationship of various communications media."(SATCOM report, p.79; see Fig. 2, p. 2 for reference)
A number of these dimensions are difficult to define, quantify and therefore display in a useful, non-empirical manner. They nevertheless represent long-term goals for a realistic portrayal of communication breakdown areas. The empirical 'viewpoint' system required is clearly very closely related to the organization information system proposed in this report. For maximum utility the two systems should no doubt be integrated as soon as is feasible.

- geographical distance; geographical emphasis (local through to international)
- 'distance' between fields of interest
- field of interest (data derived from environment) — methods of handling data
- time focus (past — future)
- objectified concept of individual in temporal-spatial continuum — stress on being in the immediate present
- logical clarity/consistency/coherence — diffuse quality
- logical reception and transmission of data — learner/educator attitude
- individual as a human being — individual as an abstract unit
- focus on individual — focus on world system; focus on self — environment
- social relevance/utility — knowledge or interest for its own sake
- self-justifying activity — purposeful activity; rewards (internal — external)
- problem orientation — group orientation; action — consequences of action
- conceptual framework for action — action; criteria for action — tradition
- immediately practical value — theoretical or abstract value
- feasibility/practicality/viability — desirability
- visible/objective conditions — values
- solution to immediate visible problems — long-term planning and condition control
- statically conceived spatio-temporal environment — developmental/dynamic
- stability/tradition/accepted procedures — change/dynamism
- active approach to environmental disturbance — passive/fatalistic approach
- sense of urgency — 'manana-ism'
- elegance — power; tender-minded — tough-minded
- signal emission strength (high — low)
- interaction with other segments of the social environment (single channel or set of channnels — diverse set of channels of many types)
- multifaceted activity (pure and applied disciplines and practical experience) — single facet activity; multidiscipline — single discipline
- pure knowledge — applied knowledge; knowledge — application
- acquisition of particular skills by individual — psychological integration of individual (personality maturity)
- individual conceived as unified entity — individual conceived as set of response
- unified/comprehensive theories (unification of knowledge) — theories with a high predictive value in a carefully defined area; synthesizers — analyzers
- visible/ socially recognized importance — creative assessment of potential importance; source of information — content of information
- peer group contact — multigroup contact
- formal organization — informal organization/groups/movements of opinion
- profession or trade — activity/social function of the profession or trade
- number of factors permitted as variables in concepts (high — low)

This list is remarkable for its crudity, but that may be considered a measure of our attention to this area.

FIG. 3 METHODS OF DISPLAYING DATA STORED IN THE COMPUTER

The following list, and the diagrams to which it refers, attempts to give some idea of the variety of projection possible on computer output terminals. Each of these can be used to convey information on different aspects of the world system and its sub-systems, or to different types of person having differing familiarity with the symbols and techniques used.

A. Organization chart (see Fig. 3A, 3B, 3C)

Complex, detailed, hierarchically-structured organization charts with descriptive text on each body listed. In the interactive version, related organizations can be examined in rapid succession and the display can be projected onto a wall screen.
Useful as a means of rapidly conveying detailed information on complex organizational linkages to persons unfamiliar with all aspects of the organization or its outside contact pattern. Could be used in meetings.

B. Inter-Organization network (2-Dimensions) (see Fig. 3D, 3F, 3H)

Detailed networks of organizations and the links between them

C. Inter-Organization network (3-Dimensions) (see Fig. 3E, 3G, 3J, 3K)

The extra dimension simulated on a visual display screen may be used when a two-dimensional picture would be too complex and detailed and the more significant organizations need to be highlighted in some way.

D. Inter-Organization network analysis (see Fig. 3M)

The computer may be used not only to store information for display, but also to analyse the relationships between organizations according to criteria specified by the user.

E. Inter-Organization network analysis over time (see Fig. 3P)

The development of an organizational complex over time may be conveniently displayed. The display could take the form of a month-by-month changes in the network portrayed in three dimensions, possibly using some interpolative display technique to facilitate understanding of gradual changes, or where information is lacking.

F. User-Oriented projection of the network (see Fig. 3L)

The manner in which a three dimensional network is displayed may be changed so that it is 'distorted' to highlight those bodies with which he is most familiar. This has important educational uses.

G. Network analysis projected into the future

Developments in the structure of the network, detected as trends in the past, may be projected into the future on a display. Propositions may be introduced to control the extrapolative process and to permit display of the network in the future under various assumptions

H. Control of the visual display screen (see Fig. 3N)

A variety of controls is available to the person using a visual display screen. These can be adjusted to permit him to select the type of display from which he can obtain the maximum amount of information most rapidly.

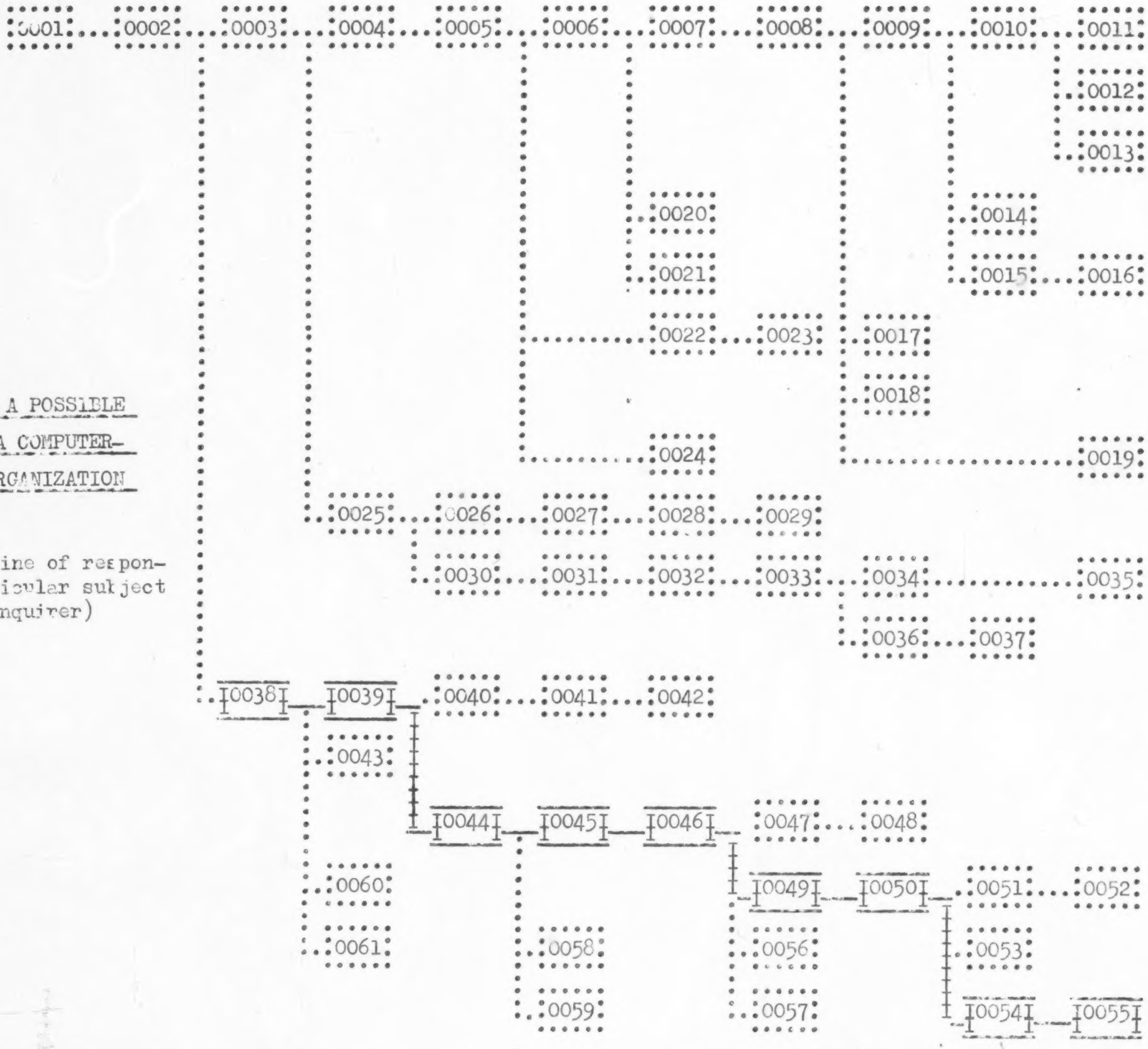
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FIG. 3A EXAMPLE OF A POSSIBLE DESIGN OF A COMPUTER-PRODUCED ORGANIZATION CHART.

(Solid line shows line of responsibility on a particular subject specified by the inquirer)

FIG.3B COMPUTER PRINTOUT OF KEY TO FIG.3A

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QUERY BL/69          8 SEPT 1970                                   PAGE 27B

INTERGOVERNMENTAL ORGANIZATION FOR DEVELOPMENT TECHNICAL PROBLEMS

(AGREEMENT SIGNED: 1953;  CURRENT MEMBERSHIP: 26 STATES, 2 ASSOCIATE)
(INFORMATION ON NATIONAL REPRESENTATIVES ON EACH COMMITTEE: ON FILE TO MARCH 1969)

QUERY SUBJECT:  TURBINE MANUFACTURE DECISIONS

0001  GENERAL ASSEMBLY (ART. 9; PLENARY; 1954; 3 YEARLY MTG; REPORT)
0002  GENERAL EXECUTIVE (ART. 9.10; OPERATIONS COORDINATION; 1953; QTLY MTG;
        REPORT)
0038  APPLICATION DIVISION (ART. 17; 1960)
0039  ENGINEERING DEPARTMENT (1960)
0040  COMMITTEE ON STANDARDIZATION (L/49; 1961)
0041  SUBCOMMITTEE ON DOCUMENTATION (M/13; 1961)
0042  WORKING GROUP ON TERMINOLOGY (Z/62; 1961)
0043  ADVISORY COMMITTEE ON PATENTS (A/9; 1963)
0044  MECHANICAL ENGINEERING COMMITTEE (B/11; 1963)
0045  WATER POWER CONTROL GROUP (P/4; 1964)
0046  WATER POWER SECTION (P/5; 1964)
0047  TASK GROUP ON MODERNIZATION OF TRADITIONAL EQUIPMENT (P/6; 1968)
0048  SUBCOMMITTEE ON CHARACTERISTICS OF TRADITIONAL EQUIPMENT IN S.E. ASIA
        (L/2; 1969)
0049  COMMITTEE ON TURBINES (Q/3; 1964)
0050  TURBINE GROUP (Q/4; 1965)
0051  CORROSION GROUP (N/16; 1967)
0052  AD HOC STUDY GROUP ON NEW MATERIALS (A/42;  1968)
0053  DESIGN GROUP (N/9;  1966)
0054  PROPELLER TURBINES (N/10; 1967)
0055  TURBINE MANUFACTURE WORKING PARTY (R/1;  1969)
0056  DAM CONSTRUCTION ADVISORY GROUP (S/32;  1964)
0057  POWER PLANT CONSTRUCTION ADVISORY GROUP (S/4;  1967)
0058  RIVER STUDY GROUP (E/2;  1964)
0059  METEOROLGICAL GROUP (E/3;  1965)
0060  ADVISORY GROUP ON NATIONAL APPLICATIONS PLANNING (A/10;  1965)
0061  AD HOC GROUP ON RIVER CONTROL POLITICAL IMPLICATIONS (A/11;  1966)


(INDEXING OPTIONS SELECTED:  SUBJECT/BODIES RESPONSIBLE
                             ORGANIZATION/NATIONAL CONTACTS
                             NATIONAL CONTACTS/ORGANIZATION)
```

(A selection of possible indexes is shown in Fig. 3C)

FIG. 3C EXAMPLES OF POSSIBLE INDEXES TO FIG. 3A AND FIG. 3B

A. Subject/Bodies responsible index

This index may be used to determine (a) who could usefully be in contact with whom with regard to each subject area, (b) who (at different levels of authority) is responsible for initiating such a contact, (c) the date of the last and next decision-making period at which such a contact could have been or could be proposed, (d) areas of possible duplication of activity. On this last point, the mandate of each body implicated in a possible duplication of activity could be printed out by the computer as a qualifier on the subject area indexing.

possible form:

SUBJECT AREA KEYWORD-A
- SUB-SUB-BODY-1 RESPONSIBLE MEETING DATA
  ADDRESS.....
- SUB-BODY-1 RESPONSIBLE MEETING DATA
  ADDRESS...
- BODY-1 RESPONSIBLE MEETING DATA
  ADDRESS...
- BODY-2 RESPONSIBLE MEETING DATA
  ADDRESS...
- SUB-BODY-3 RESPONSIBLE MEETING DATA
  ADDRESS....
- BODY-3 RESPONSIBLE MEETING DATA
  ADDRESS...

SUBJECT AREA KEYWORD-B
......etc

B. Organization/National contacts index

By cross-linking two organizational structures, e.g. an intergovernmental organization and the member states administrative structures, the contact points and 'opposite numbers' can be highlighted, as well as the chain of responsibility

possible form:

INTERGOVERNMENTAL COMMITTEE ON RIVER POLICY
- ITALY
  - R.S. PERINI (1968)
    TECHNICAL ADVISOR
    RIVER PROTECTION SECTION
    MINISTRY OF AGRICULTURE
- UNITED KINGDOM
  - L.N. BROWN (1966)
    COORDINATOR
    ADVISORY GROUP ON RIVER POLLUTION
    MINISTRY OF TECHNOLOGY
  - N.P. SMITHERS (1967)
    RESEARCH DIRECTOR
    RIVER NAVIGATION INSTITUTE
    HOME OFFICE
- etc....

INTERNATIONAL SOCIETY FOR RIVER PROTECTION
- etc....

Fig. 3C (contd.)

C. National contacts/Organization index

Inverting this last index, an index by country is obtained. In other words a directory of all the bodies within any given country concerned with a specified range of subjects is obtained. It indicates which of these bodies, institutes, departments, or societies are in contact with which, for example, international organization.

possible form:

CANADA
- MINISTRY OF AGRICULTURE AND FISHERIES
  - PLANT PROTECTION DIVISION
    - INTEGOVERNMENTAL COMMITTEE ON PLANTS
    - FAO ADVISORY GROUP ON PLANTS
    - INTER-AMERICAN PLANT PROTECTION ORGANIZATION

      ...etc...
  - SALMON FISHING DIVISION
    - EAST ATLANTIC SALMON FISHING BUREAU
    - ...etc..
- MINISTRY OF TECHNOLOGY
  - ...etc...

DOMINICAN REPUBLIC
- ...etc...

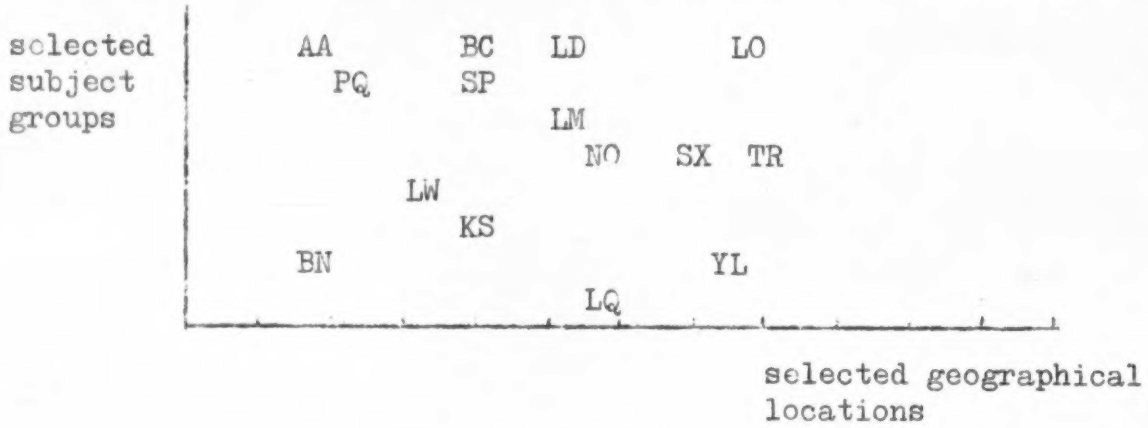
D. Other indexes

Indexes need not be restricted to one type of structure. It should be possible to select and reselect suitable indexes with great flexibility. An index might include all the meetings, programmes, ad hoc groups concerned with a particular subject area, as well as the formal organizations. Similarly it should be possible to merge in or select out information on international, regional, national or local bodies, whether governmental or nongovernmental, profit or nonprofit, etc. In this way rigid categories may be used when necessary, but do not distort the value of the information system for other users, or when the categories have to be reshuffled to structure contacts for a new type of problem.

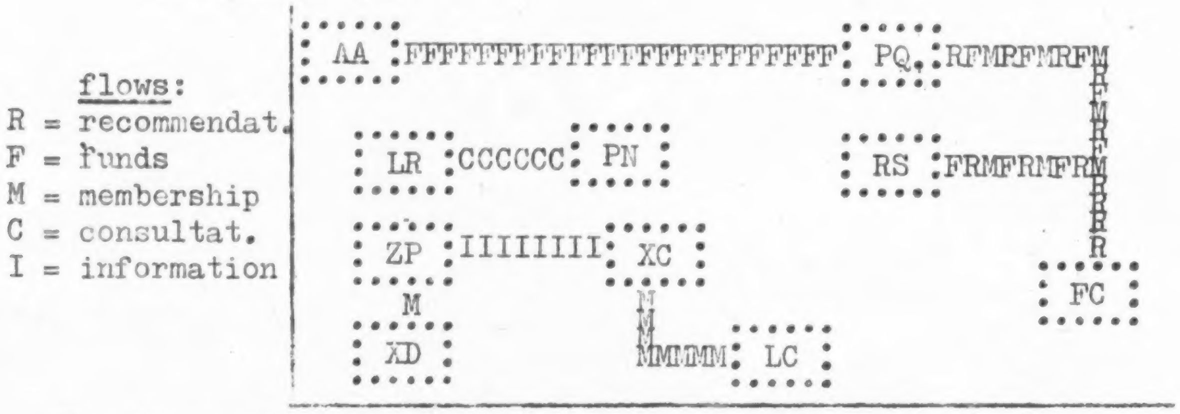
E. Other information

Clearly in many cases a simple index will be quite inadequate. It is quite possible, however, to print out more information against each index entry. Some possibilities are: date and place of last and future meetings, whether a report was published for the last meeting, budget of the organization, date of establishment and relevant legal data, or the last time a particular country was represented on the executive, etc.

FIG. 3D EXAMPLES OF 2-DIMENSIONAL DISPLAYS OF INTER-ORGANIZATIONAL LINKS

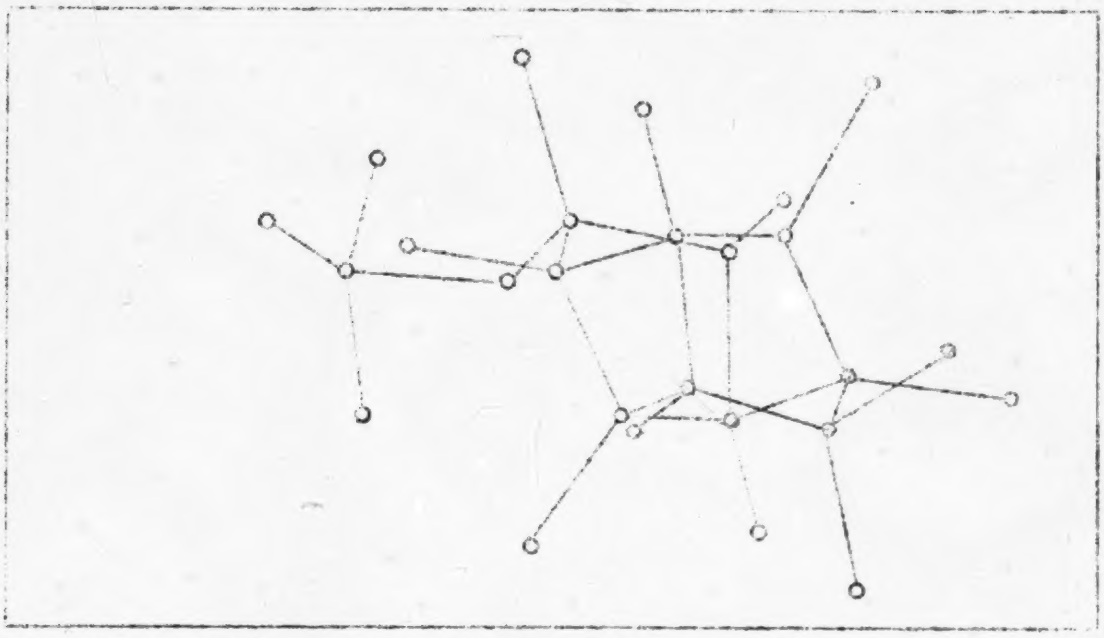

selected subject groups
AA
BC
LD
LO
PQ
SP
LM
NO
SX
TR
LW
KS
BN
YL
LQ
selected geographical locations

A. Identification numbers of organizations are printed or displayed within a 2-dimensional frame. Coordinates, groups and scale are specified by the user. Axes can be chosen to represent field of interest keycoding, geographical location coding, any size criterion (number of members, budget, etc.), etc. A conversion table, giving the name and other details of the organization could also be produced. Where many organizations fall at the same point in the frame, the identification numbers would represent a group which would be listed together in the conversion table


flows:
R = recommendat.
F = funds
M = membership
C = consultat.
I = information
AA
FFFFFFFFFFFFFFFFFFFFFFFFFF
PQ
RFMRFMRFM
LR
CCCCCC
PN
RS
FRMFRMFRM
ZP
IIIIIII
XC
R
FC
M
M
M
XD
MMMMM
LC

B. As an extension of 'A' the types of flows linking different organizations or groups of organizations could be displayed. There are many possible extentensions to the above flowchart. Additional details can be added (contact frequency, flow volumes, flow quality rankings, etc.). At the same time as this is produced, an analysis of those entities or classes of entity which are not in contact, according to a user defined criteria of acceptability could also be made and later displayed.

Main uses of this type of display could be in providing a rapid printed summary of organizations operating in the same field, either to inform them of each others existence, or to facilitate the task of committees discussing issues in connection with that field



circles = nodes or organizational entities

lines = links or relationships between entities

FIG. 3E EXAMPLE OF THE TYPE OF 3-DIMENSIONAL STRUCTURE WHICH IT IS NOW POSSIBLE TO DISPLAY ON A COMPUTER TERMINAL.: As part of a complex organizational network, the links to other parts could be ignored. The displayed part, or subsystem, could then be increased in size or rotated by the computer to facilitate greater understanding of the relationship between the organizational entities included. (The example is a representation of a chlorosulphate molecule taken from OKAYA, Y. Interactive aspects of crystal structure analysis. IBM Systems Journal, vol. 7, 3 & 4, 1968, p. 322-330) The three coordinate dimensions are selected by the user in order to highlight those aspects of the structure/relationships of most interest to him.

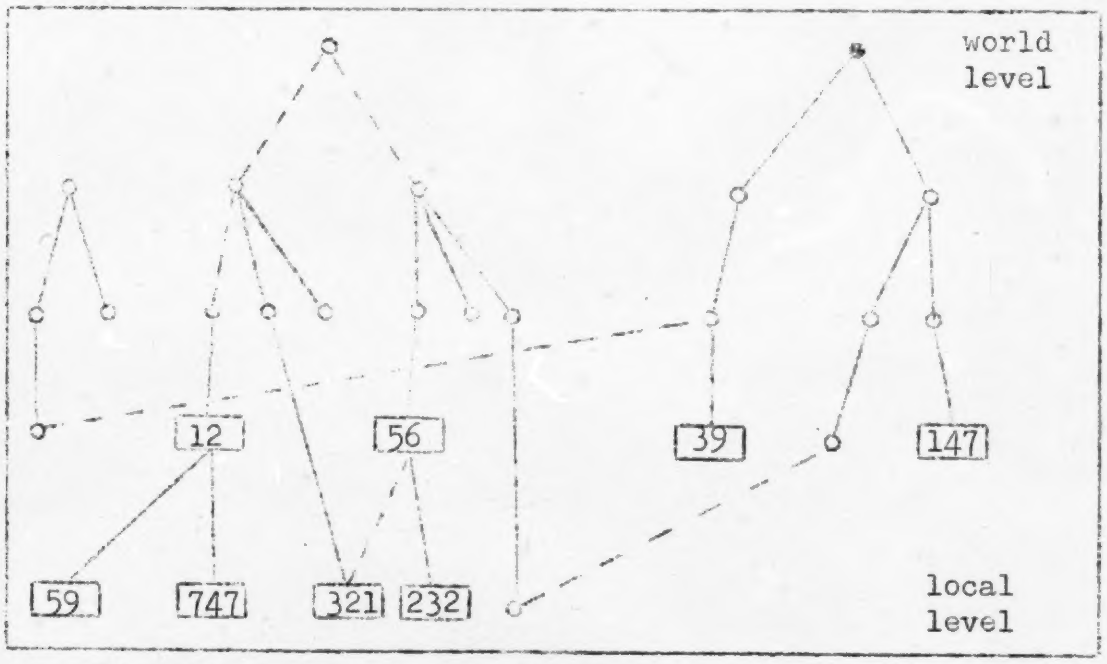


FIG. 3F EXAMPLE OF A 2-DIMENSIONAL CHART WHICH IT IS POSSIBLE TO DISPLAY ON A COMPUTER TERMINAL. The dimensions chosen by the user ensure that the most 'coordinative' entities are positioned at the top of the frame. Boxes indicate a set of numerous entities which it would be confusing or unnecessary to display. This display is an extension of the use of an internal organization chart to an 'inter-organization' chart.

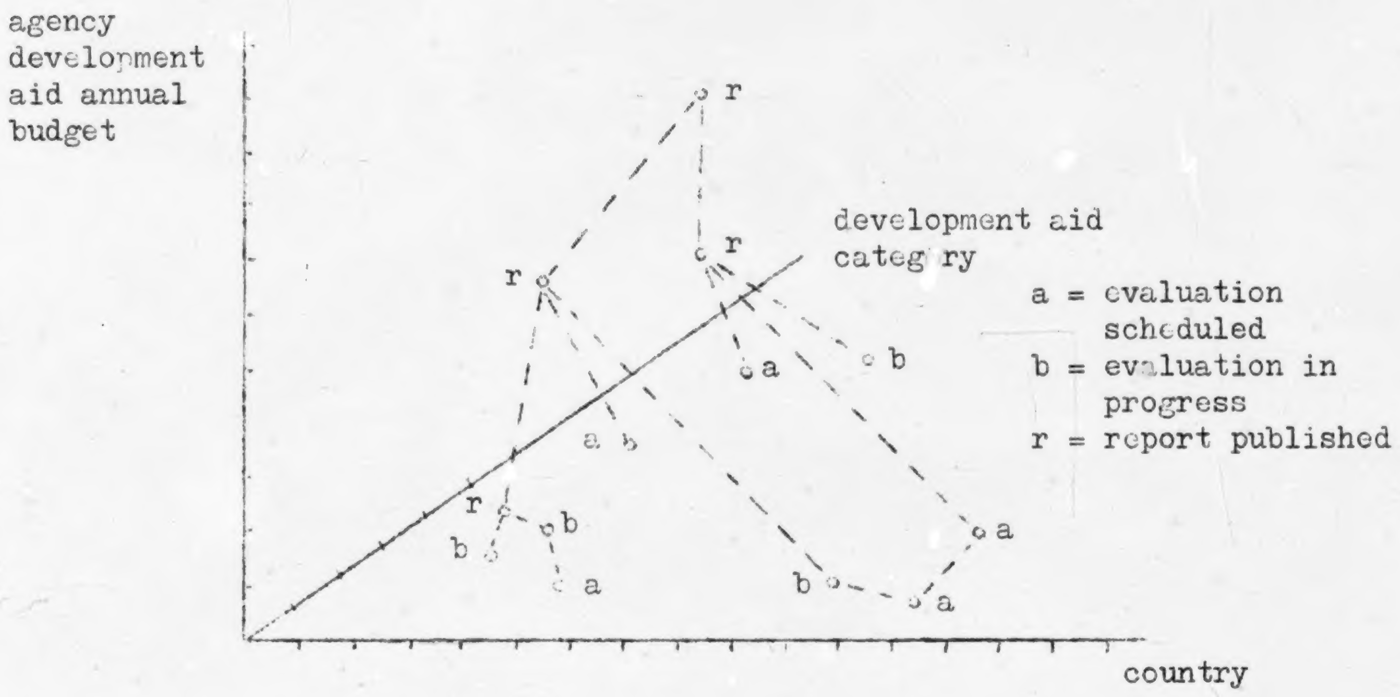

agency development aid annual budget
r
r
r
r
development aid category
a = evaluation scheduled
b = evaluation in progress
r = report published
a
b
a
b
r
b
b
a
a
b
a
a
country

FIG. 3G SIMPLIFIED EXAMPLE OF USE OF 3-DIMENSIONAL DISPLAY TO FOLLOW THE USE OF DEVELOPMENT AID FUNDS. Aid funds may be channelled through a number of agencies. This type of display assists in detection of overlap and could indicate the status of evaluation of the use of the funds. Much statistical information can be compressed onto this and related displays as a convenient method of presenting complex interacting factors as an aid to decision-making.

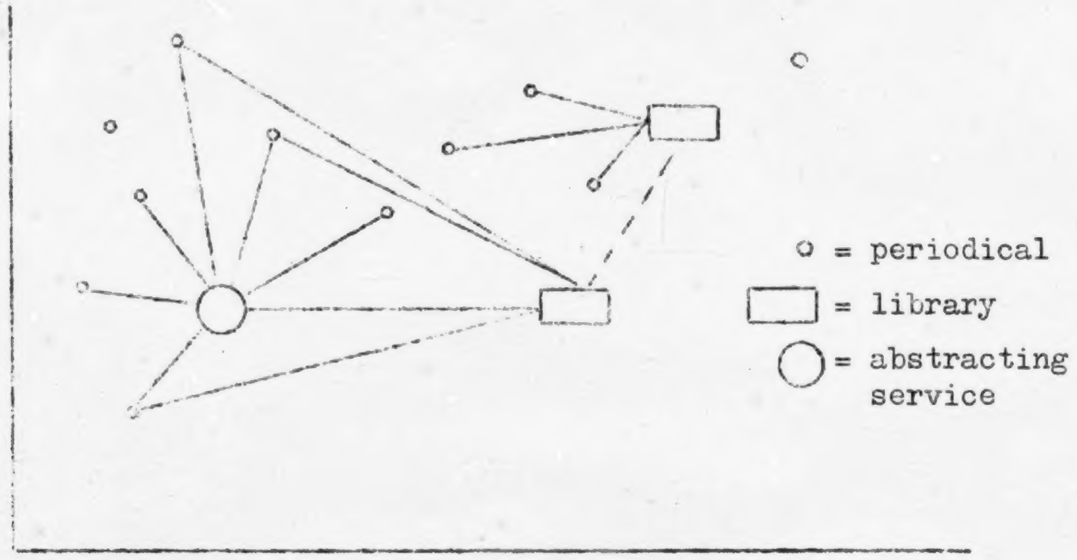

○ = periodical
▭ = library
◯ = abstracting service

FIG. 3H SIMPLIFIED EXAMPLE OF USE OF A 2-DIMENSIONAL DISPLAY TO EXAMINE AN INFORMATION NETWORK. The network of periodicals, abstracting services, depositary libraries, bibliographical services, etc. in interacting and overlapping subject areas can be followed with precision. Introduction of volume figures and coverage percentages permits automatic analysis to highlight weaknesses in bibliographical coverage or the pattern of accessions to a library. Introduction of cost to user and physical locations permits automatic preparation of 'information availability' maps to indicate barrier to use by any particular category of user

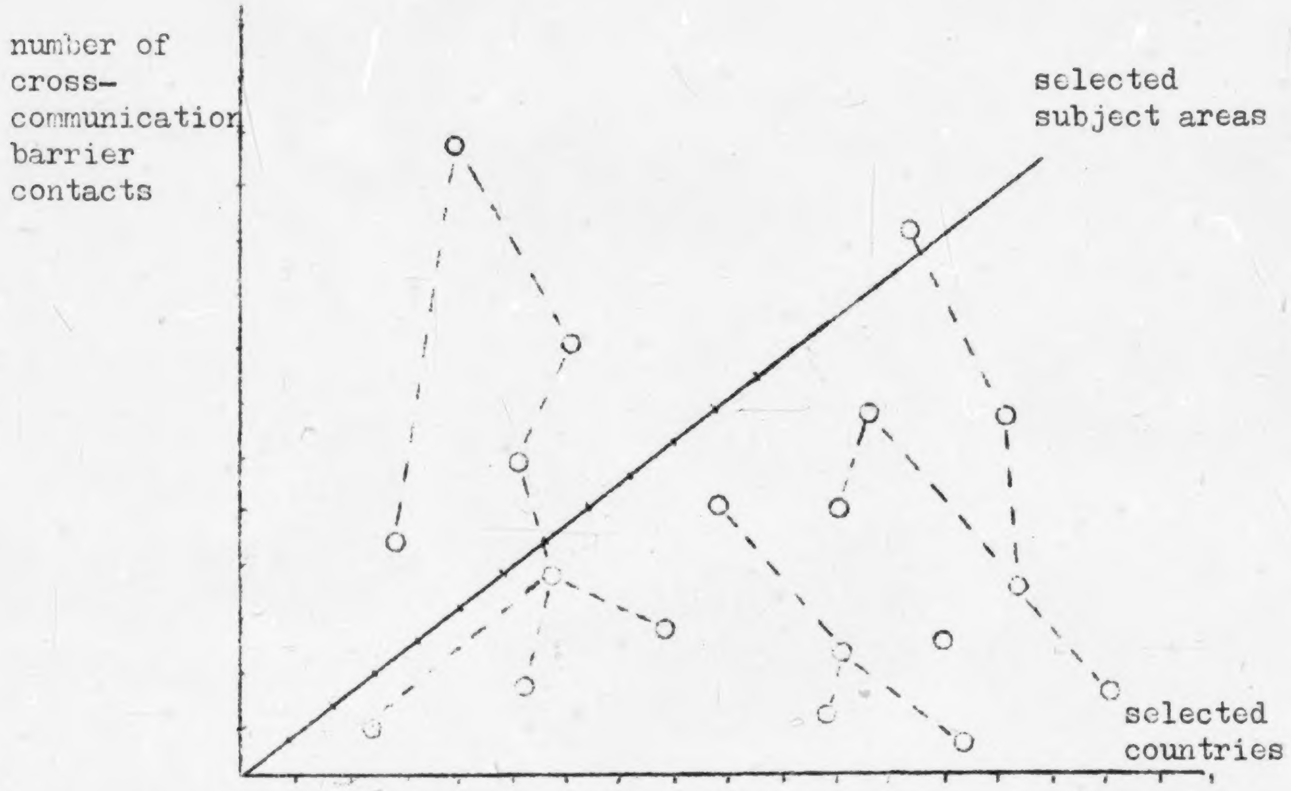

number of
cross-
communication
barrier
contacts
selected
subject areas
selected
countries

FIG. 3J SIMPLIFIED EXAMPLE OF USE OF 3-DIMENSIONAL DISPLAY TO STUDY INTERDISCIPLINARY, CROSS-JURISDICTIONAL CONTACT PATTERNS. Such a display could be used to highlight unambiguously areas where cross-displinary contacts and interaction is poor or where a particular discipline's results are not influencing those of a second discipline concerned with the same problem area

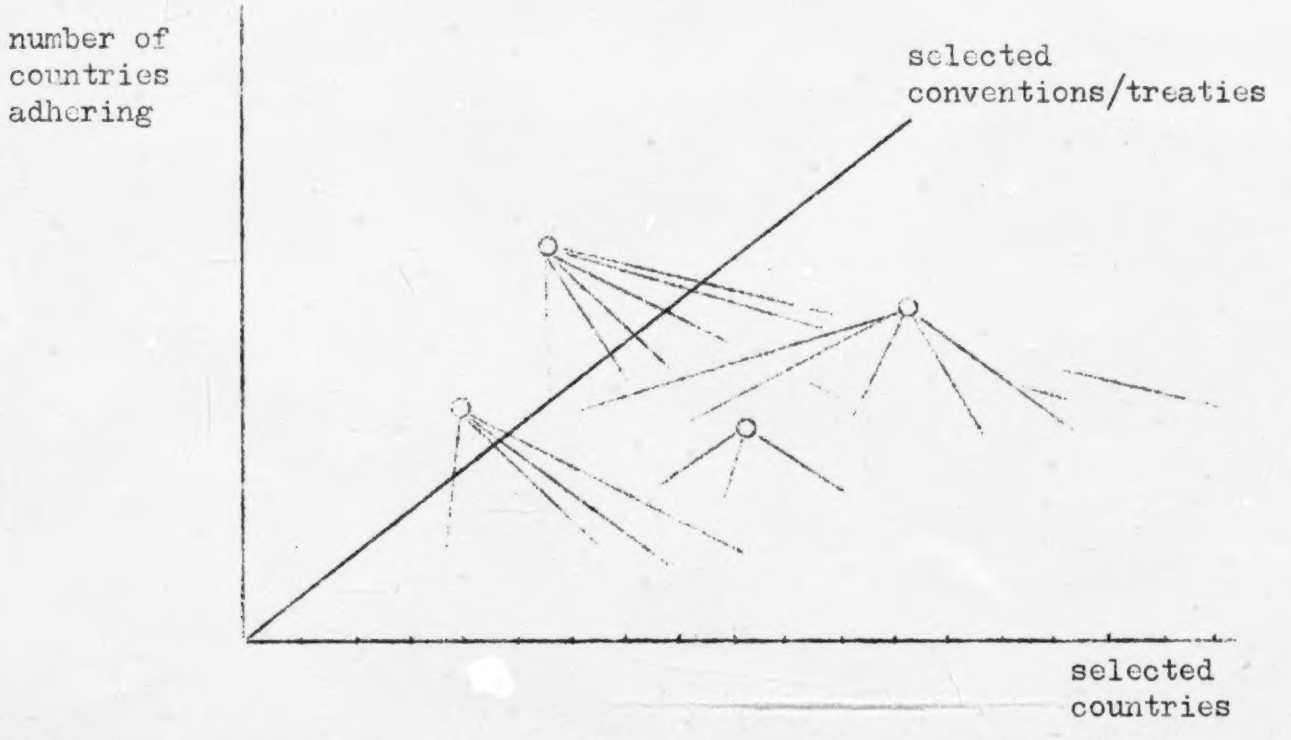
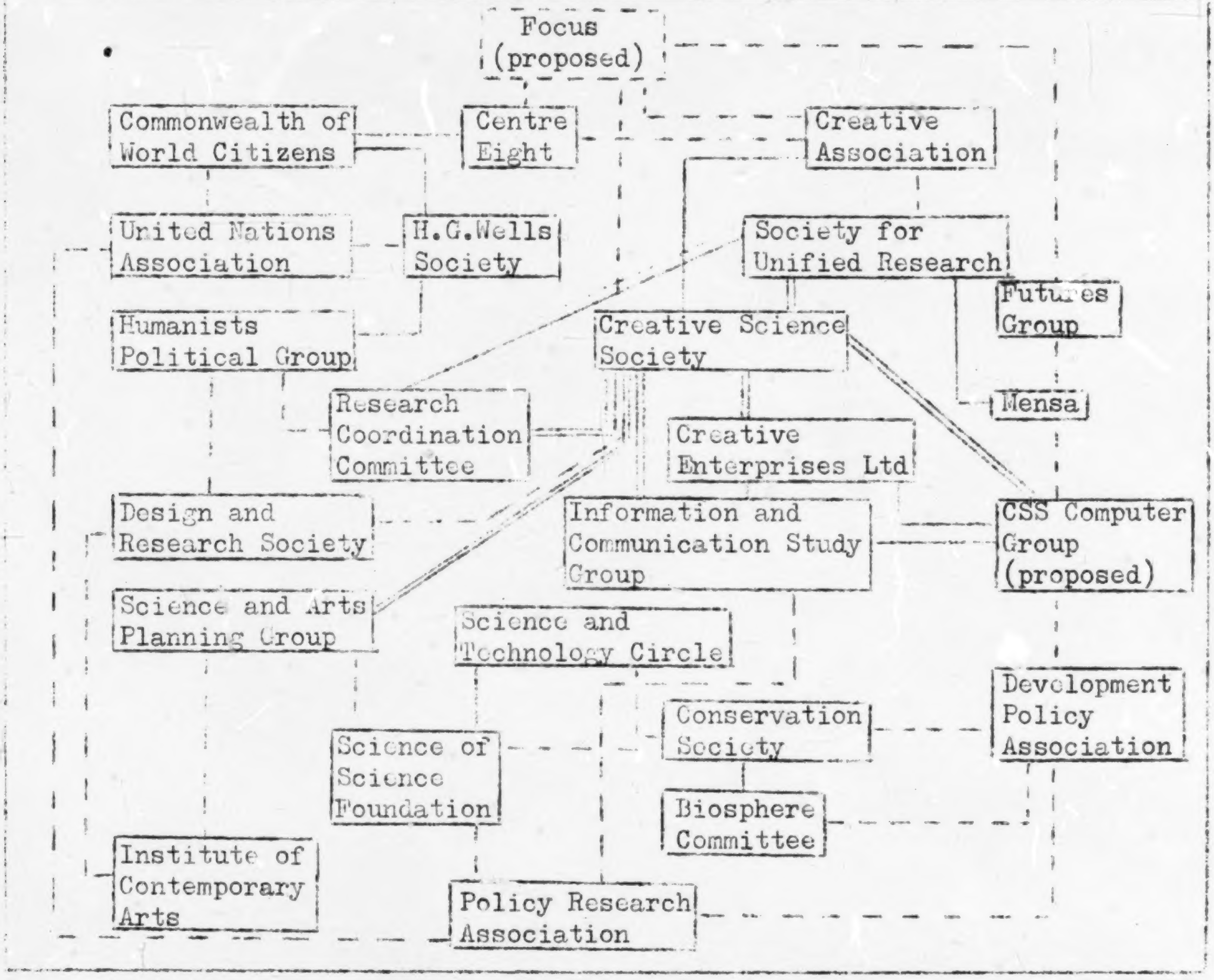

number of
countries
adhering
selected
conventions/treaties
selected
countries

FIG. 3K SIMPLIFIED EXAMPLE OF USE OF 3-DIMENSIONAL DISPLAY TO STUDY THE PATTERN OF ADHERENCE TO INTERNATIONAL TREATIES. Such a display, together with a second one relating treaties to subject areas covered, could be used to highlight subjects or countries in which international treaty coverage did not exist or where there was duplication between treaties.

FIG. 3L EXAMPLE OF AN INTER-ORGANIZATION NETWORK DISPLAYED ON A COMPUTER TERMINAL WHICH HIGHLIGHTS ORGANIZATIONS OF MOST INTEREST TO THE USER.

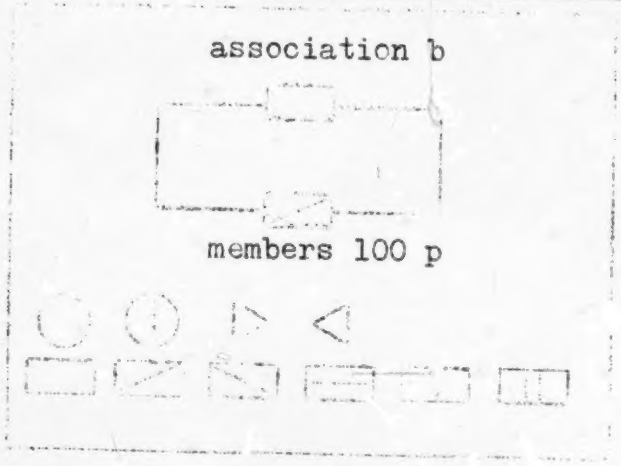
This gives some indication of the type of display which would be used for educational or communication research purposes. The size of the symbol used to portray the organization (or meetings, journals, etc.) could be made a function of its 'sociological' or 'psychological distance' from the user. In this example, the network is focused on the Creative Science Society, as seen by a person with a strong involvement in that body. The emphasis is on nongovernmental bodies.


Focus (proposed)
Commonwealth of World Citizens
Centre Eight
Creative Association
United Nations Association
H.G.Wells Society
Society for Unified Research
Futures Group
Humanists Political Group
Creative Science Society
Research Coordination Committee
Mensa
Creative Enterprises Ltd
Design and Research Society
Information and Communication Study Group
CSS Computer Group (proposed)
Science and Arts Planning Group
Science and Technology Circle
Development Policy Association
Conservation Society
Science of Science Foundation
Biosphere Committee
Institute of Contemporary Arts
Policy Research Association

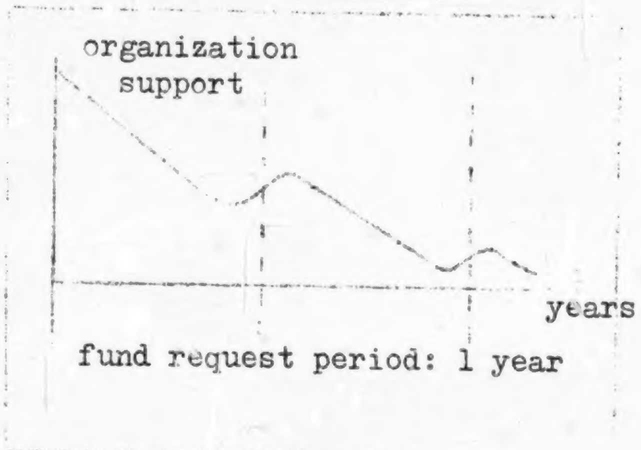
Faced with this type of display, the user may, for example, access details on any particular organization prior to switching the network to focus on the links based on that organization. The user could also access information on the nature of the links between organizations, their frequency, the status of proposed modifications, and also simulate strategies for strengthening links. By switching to a flowchart presentation, the user could also examine the consequences of eliminating certain links or dissolving particular organizations, or even of creating new organizations with certain specified characteristics and links.

An important use of this display would be to inform or brief persons in government or in large organizations who are frequently faced with the necessity to 'size up' a new inter-organization situation. This is the ideal method of providing an overall view, whilst at the same time permitting exploration of detail to get a feel for the situation.

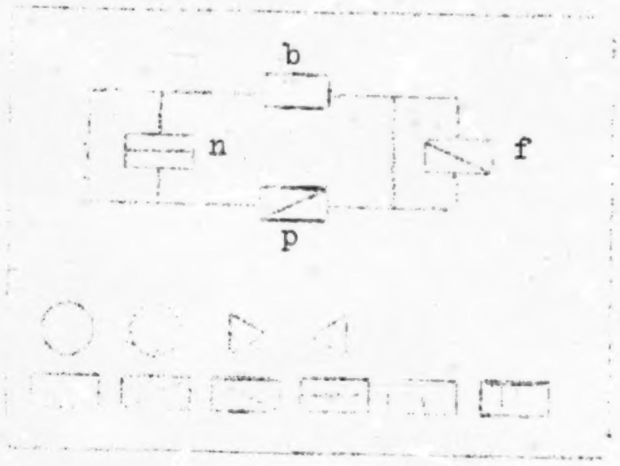
FIG. 3M EXAMPLE OF GRAPHICAL PRESENTATION AND ANALYSIS OF FLOWCHARTS



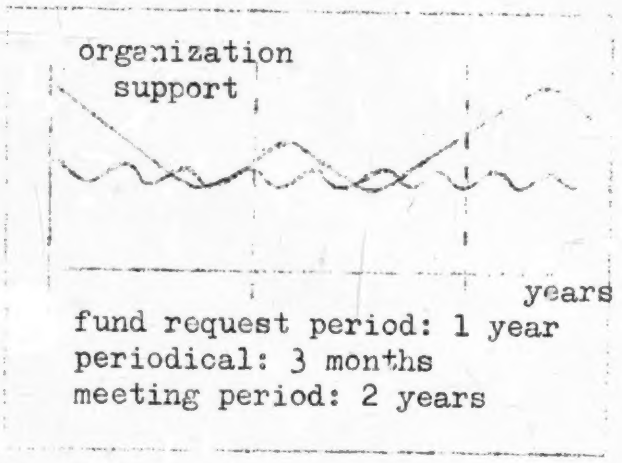
1a. Type 'b' association with 100 type 'p' members. Many other organizational entities could be included in the vocabulary



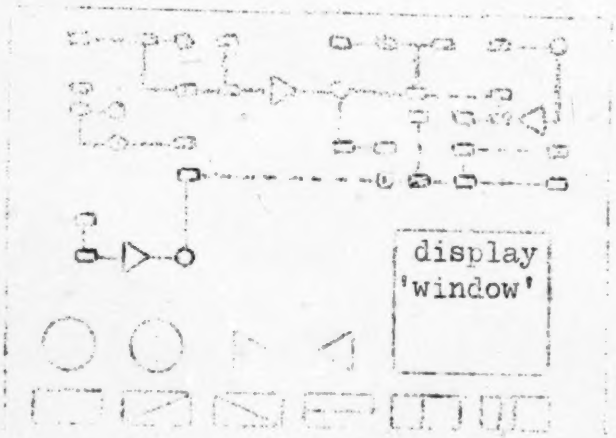
1b. Resultant probable diminution of support over time, due to lack of adequate supportive feedback to members



2a. Addition to 1a. of 2-yearly type 'f' meeting plus quarterly type 'n' periodical to members



2b. Maintenance of organization support due to quarterly, annual and 2-yearly stimulus



3a. Impression of a view of a detailed flowchart. Much more complex flowcharts could be represented and analysed in this way, though only sections of large charts could be displayed at one time.

Sequence of views of computer terminal display screen, showing a means of linking organizational entities in a flowchart and analysing the flowchart when quantitative characteristics are specified for each entity

- The vocabulary of entities recognized by the computer is displayed below the work area. The researcher indicates which entity to use, where, and how they are to be linked, by pointing and drawing with a light-pen on the screen (the computer straightens sketched flowchart lines)
- The researcher can specify for which parts of the flowchart an analytical curve is required, with variables and assumptions
- The flowcharts are shown with only one type of flow (information), other types could be shown or selected out
- Flowcharts may either be constructed by the researcher or based on data bank information on real organizational entities.

FIG. 3N CONTROLS AVAILABLE TO THE USER WHEN INTERACTING WITH THE COMPUTER AND THE DATA BANK VIA THE VISUAL DISPLAY TERMINAL

A Light-pen: permits user to indicate to the computer individual organizations displayed in a network or flowchart for which some special instruction is to be given via the keyboard; also used for drawing lines and indicating relationships between organizations displayed (e.g. to show between which points of a network a specified type of analysis is required).

B Organization characteristic keys: the user can define a set of keys (on a typewriter style keyboard) to have special meanings. Use of a key can lead to the display of one particular type of information about a single organization in a displayed network. Keys might be used for: budget range, membership range, frequency of activity, information collecting, storage and republication codes, or any data introduced as a result of a special survey by the user. Similarly keys might be used to request the highlighting of information, membership, policy or financial relationships between organizational entities.

C Organization type keys: the user can supply his own set of categories to distinguish between classes of organizational entity. Organizations of a particular type (e.g. intergovernmental) could be retained on the display by pressing the appropriate keys. Keys might successively draw attention to organizations, councils, committees, congresses, symposia, governmental bodies, non-profit private bodies, journals, abstracts, programmes, treaties or any combination of these as defined by the user.

D Numeric keys: the user can make use of the numeric keyboard to specify quantitative data about organizational entieis or interactions displayed. For example, the user might change the budget code of a particular organization (indicated with the light-pen) in a displayed network or flowchart, in order to study the changed performance of the system under examination.

E Context keys: the user might wish to look at an organizational network or flowchart in terms of subject areas, geographical areas of activity, geographical areas of membership, etc. Keys could be allocated to select the appropriate presentation.

F Projection keys: the user might wish to change projection from: 3-D network, 2-D network, flowchart, etc. Keys could be allocated to select the appropriate presentation.

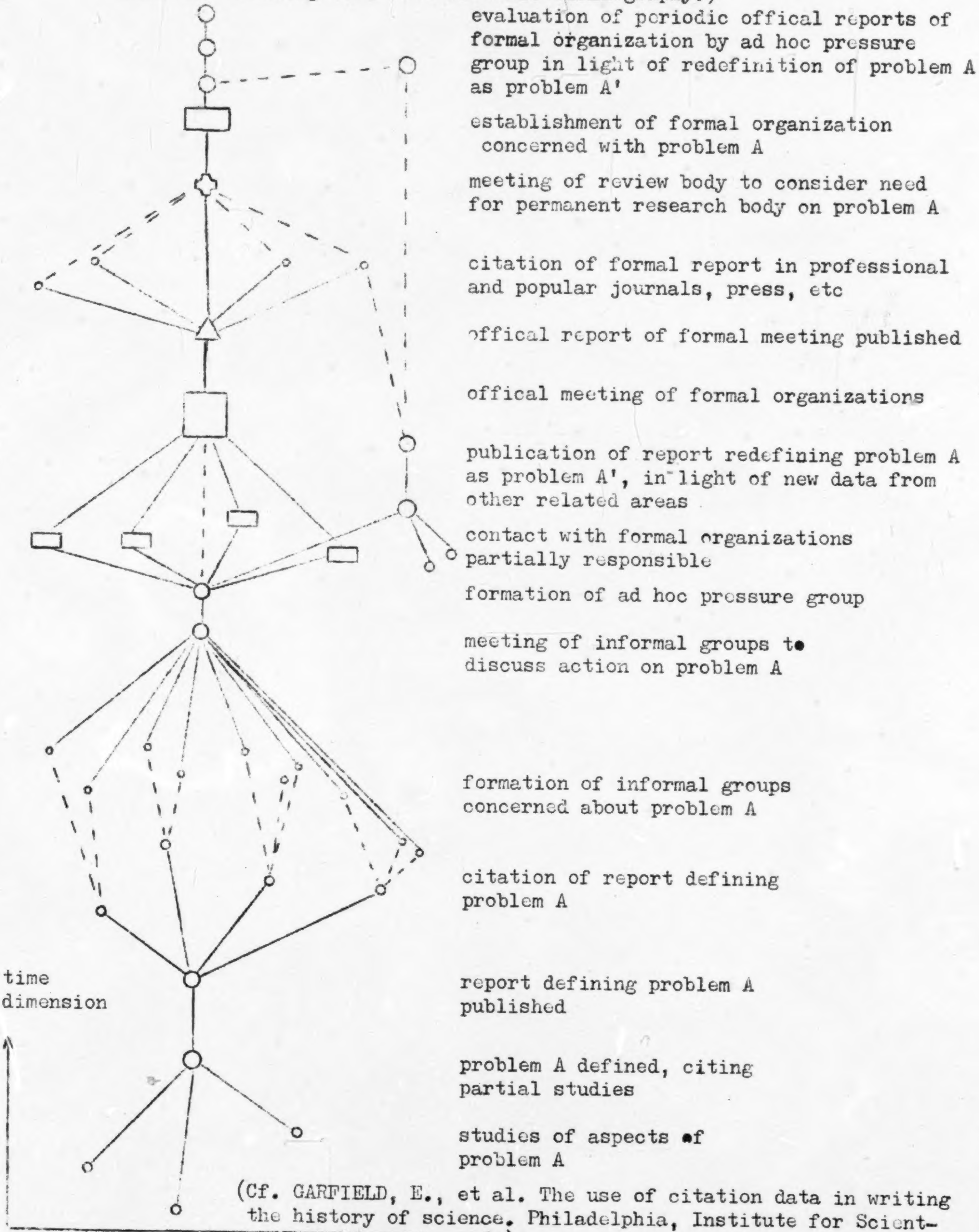
G Manipulation keys: the user might wish to include or exclude detail, rotate a 3-D network, switch to examination of a different subject or geographical area of the network, etc. Keys could be allocated to select the appropriate change.

H Display type keys: the user might wish to switch between a display of organizations, graphs of probable responses based on analyses, textual description, etc. Keys could also be allocated to permit the creation of insets or windows on the display surface to allow two types of display at the same time (e.g. flowchart under study and response curves).

I Ordering keys: the user might wish to structure a 2-D network so as to place the most significant organizations at the top or left hand side of the display. In this way, 'coordinative', financially strong, policy sources, etc. organizations could be isolated.

J Summarizing keys: the user might wish to summarize a large number of detailed interactions of many organizational entities. As, for example, the importance of inter-organization or inter-subsystem interactions increases, the detailed flowcharting or intra-organization or intra-subsystem interaction can be summarized for calculation and display purposes, on user command, into 'boxes' with averaged characteristics. In this way any level of the world system can be portrayed.

FIG. 3P SIMPLIFIED EXAMPLE OF USE OF 2-DIMENSIONAL DISPLAY TO TRACK THE FORMATION OF AN ORGANIZATION AND ITS INTERACTION WITH PRESSURE GROUPS. (A technique which could be developed from a special use of citation indexing files for historio-bibliography.)


evaluation of periodic offical reports of formal organization by ad hoc pressure group in light of redefinition of problem A as problem A'
establishment of formal organization concerned with problem A
meeting of review body to consider need for permanent research body on problem A
citation of formal report in professional and popular journals, press, etc
offical report of formal meeting published
offical meeting of formal organizations
publication of report redefining problem A as problem A', in light of new data from other related areas
contact with formal organizations partially responsible
formation of ad hoc pressure group
meeting of informal groups to discuss action on problem A
formation of informal groups concerned about problem A
citation of report defining problem A
report defining problem A published
problem A defined, citing partial studies
studies of aspects of problem A
time dimension

(Cf. GARFIELD, E., et al. The use of citation data in writing the history of science. Philadelphia, Institute for Scientific Information, 1964)